TOTAL MAXIMUM DAILY LOADS FOR NITROGEN COMPOUNDS AND RELATED EFFECTS

CALLEGUAS CREEK, TRIBUTARIES, AND MUGU LAGOON

STAFF REPORT

California Regional Water Quality Control Board
Los Angeles Region

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1 INTRODUCTION

Segments of Calleguas Creek, its tributaries, and Mugu Lagoon are impaired by nitrogen compounds and eutrophic effects, including low dissolved oxygen, organic enrichment, and algae and are included on the United States Environmental Protection Agency (EPA) 1998 303(d) list of impaired waterbodies in California. The Clean Water Act requires Total Maximum Daily Loads (TMDLs) be developed to restore impaired waterbodies, and the Porter-Cologne Water Quality Act requires that an Implementation Plan be developed to achieve water quality objectives. This document fulfills these statutory requirements and serves as the basis for amending the *Water Quality Control Plan for the Los Angeles Region (Basin Plan)* to achieve water quality standards in Calleguas Creek for nutrients. This document contains:

- a description of the Calleguas Creek watershed including the nitrogen and related effects impairments of Calleguas Creek,
- the data and methods to develop the nitrogen and related effects TMDL for Calleguas Creek,
- waste load and loads allocations of nutrient sources in the Calleguas Creek Watershed, and
- an Implementation Plan to achieve water quality objectives for nitrogen and related effects in Calleguas Creek.

This TMDL addresses the requirements prescribed by Section 303(d) of the Clean Water Act, 40 CFR 130.2 and 130.7, and U.S. Environmental Protection Agency guidance (U.S. EPA, 1991). This TMDL is based on the analysis provided in Calleguas Creek Nutrient TMDLs, 2000 by Larry Walker and Associates under contract to the Calleguas Municipal Water District with partial support from a Clean Water Act section 205(j) grant. The Calleguas Creek Nutrient TMDLs, 2000 by Larry Walker and Associates is referenced throughout this staff report as the "Technical Support Document."

The Implementation Plan of this TMDL is designed to attain water quality objectives for oxidized nitrogen, and ammonia (collectively the nitrogen compound objectives) in Calleguas Creek. Attaining the nitrogen compound objectives will likely address ancillary nutrient effects, including dissolved oxygen and algal growth. The implementation plan requires continued studies to verify this assumption. However, there are insufficient data to characterize nitrogen sources from groundwater, septic systems, wet weather urban runoff, and agricultural drainage and runoff. There are also limited data regarding nitrogen and eutrophic impairments of Mugu Lagoon. Consequently, the Implementation Plan includes special studies to assess these parameters. Should these studies demonstrate that eutrophic impairments would not be eliminated through attainment of the nitrogen targets proposed in this TMDL, the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) may revise targets and reallocate loads through a reopener included in the Implementation Plan. Additional discussion is provided in the Implementation Plan of this document.

1.1 REGULATORY BACKGROUND

Section 303(d) of the Clean Water Act (CWA) requires that "Each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in the U.S. Environmental Protection Agency guidance (U.S. EPA, 1991). A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loadings (the Loading Capacity) is not exceeded. TMDLs are also required to account for seasonal variations, future growth and include a margin of safety to address uncertainty in the analysis.

States must develop water quality management plans to implement the TMDL (40 CFR 130.6).

The U.S. EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. If the U.S. EPA disapproves a TMDL submitted by a state, U.S. EPA is required to establish a TMDL for that waterbody.

The Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs are required (LARWCQB, 1996, 1998). A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., *et al*. v. Browner C 98-4825 SBA) approved on March 22, 1999. The consent decree combined waterbody pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. According to the consent decree, the Calleguas Creek Nitrogen compounds and Related Effects TMDL was scheduled for adoption by the Regional Board by March, 2002. In accordance with the consent decree, this document summarizes the analyses performed and presents the TMDL for nitrogen compounds and related effects for Calleguas Creek.

Ammonia is one of the key nitrogen compounds addressed by this TMDL. The *Basin Plan* includes an objective-specific compliance schedule for the inland surface water ammonia objectives. Specifically, the *Basin Plan* provided dischargers until June 13, 2002, 8 years from adoption of the *Basin Plan*, to make the necessary adjustments and improvements to meet the objectives or to conduct studies leading to an approved site-specific objective for ammonia. At public hearings on January 11, 2001 and May 31, 2001, the Regional Board heard status reports on Public Own Treatment Works (POTWs) progress toward compliance with inland surface water ammonia objectives from Regional Board staff. The status report indicted that Camarillo Sanitary District Wastewater Treatment Plant and Camrosa Wastewater Reclamation Facility are in compliance with the ammonia objective. Hill Canyon Wastewater Treatment Facility, Simi Valley Water Quality Control Facility, and Moorpark Wastewater Treatment Plant have done some research, modified the treatment plants and some experimentation with process operation took place. However, without fully nitrifying and denitrifying, these POTWs will not be able to meet the water quality objective for ammonia, nitrite and nitrate.

In addition to the Federal and State regulations described above, the Regional Board enacted Resolution No. 97-10, *Support for Watershed Management in the Calleguas Creek Watershed* on April 7, 1997. Resolution 97-10 recognized watershed management as an innovative, cost-effective strategy for the protection of water quality. Resolution 97-10 also recognized that the Calleguas Creek Municipal Water District and the POTWs in the Calleguas Creek watershed had worked cooperatively with the Regional Board to develop an integrated watershed-wide monitoring program. Resolution 97-10 provided relief from compliance with effluent limits based on water quality objectives for ammonia, nitrite and nitrate until June 2002 to the extent permitted by law, provided that the POTWs continued to show good faith and active participation in the Calleguas Creek watershed process.

1.2 PROBLEM STATEMENT

Nutrient loadings to Calleguas Creek result in impairments of beneficial uses associated with aquatic life habitat, secondary contact recreation and groundwater recharge, among others. Ammonia concentrations exceed water quality standards for chronic and acute toxicity in some reaches of Calleguas Creek. Nitrate and nitrite concentrations often exceed water quality objectives in some reaches of Calleguas Creek. These nitrogen compounds may also stimulate the production of excessive algae mats which has been observed in certain reaches of Calleguas Creek and can result in eutrophic conditions characterized by low dissolved oxygen concentrations.

Table 1 summarizes the 1998 California 303(d) list of nutrient and related effects for Calleguas Creek according to reach and location. Reach descriptions in Table 1 are as reflected in the 303(d) list and these reach descriptions are for listing purposes only and are not to be confused with the reach descriptions defined in the *Basin Plan* or in this TMDL. Figure 1 shows the impaired waterbody segments as listed in Table 1.

TABLE 1 1998 US EPA 303(D) LISTINGS OF CALLEGUAS CREEK - NITROGEN COMPOUNDS AND RELATED EFFECT IMPAIRMENTS

Nutrient/Effect	Impaired Waterbody/Segment	Extent	
Algae	REVOLON SLOUGH MAIN BRANCH (MUGU LAGOON TO CENTRAL AVENUE)	8.9	Miles
Algae	CONEJO CREEK REACH 1 (CONFL CALL TO SANTA ROSA RD)	5.8	Miles
Algae	BEARDSLEY CHANNEL (ABOVE CENTRAL AVENUE)	6.16	Miles
Algae	CONEJO CREEK REACH 2 (SANTA ROSA RD TO THO. OAKS CITY LIMIT)	2.67	Miles
Algae	CONEJO CREEK REACH 3 (THOUSAND OAKS CITY LIMIT TO LYNN RD.)	5.6	Miles
Algae	CONEJO CREEK REACH 4 (ABOVE LYNN RD.)	4.98	Miles
Ammonia	CALLEGUAS CREEK REACH 1 (ESTUARY TO 0.5MI S OF BROOME RD)	2.2	Miles
Ammonia	ARROYO LAS POSAS REACH 1 (LEWIS SOMIS RD TO FOX BARRANCA)	1.99	Miles
Ammonia	CALLEGUAS CREEK REACH 2 (0.5 MI S OF BROOME RD TO POTRERO RD	2.3	Miles
Ammonia	CONEJO CREEK REACH 1 (CONFL CALL TO SANTA ROSA RD)	5.8	Miles
Ammonia	ARROYO LAS POSAS REACH 2 (FOX BARRANCA TO MOORPARK FWY (23))	9.62	Miles
Ammonia	ARROYO SIMI REACH 1 (MOORPARK FRWY (23) TO BREA CYN)	7.58	Miles
Ammonia	CONEJO CREEK REACH 2 (SANTA ROSA RD TO THO. OAKS CITY LIMIT)	2.67	Miles
Ammonia	CONEJO CREEK / ARROYO CONEJO NORTH FORK	6.51	Miles
Ammonia	CONEJO CREEK REACH 3 (THOUSAND OAKS CITY LIMIT TO LYNN RD.)	5.6	Miles
Ammonia	CONEJO CREEK REACH 4 (ABOVE LYNN RD.)	4.98	Miles
Nitrate and Nitrite	ARROYO LAS POSAS REACH 1 (LEWIS SOMIS RD TO FOX BARRANCA)	1.99	Miles
Nitrate and Nitrite	CALLEGUAS CREEK REACH 3 (POTRERO TO SOMIS RD)	7.7	Miles
Nitrate and Nitrite	ARROYO LAS POSAS REACH 2 (FOX BARRANCA TO MOORPARK FWY (23))	9.62	Miles
Nitrogen	CALLEGUAS CREEK REACH 1 (ESTUARY TO 0.5MI S OF BROOME RD)	2.2	Miles
Nitrogen	DUCK POND AGRICULTURAL DRAIN/ MUGU DRAIN/OXNARD DR #2	13.5	Miles
Nitrogen	MUGU LAGOON	2000	Acres
Nitrogen	REVOLON SLOUGH MAIN BRANCH (MUGU LAGOON TO CENTRAL AVENUE)	8.9	Miles
Nitrogen	CALLEGUAS CREEK REACH 2 (0.5 MI S OF BROOME RD TO POTRERO RD	2.3	Miles
Nitrogen	BEARDSLEY CHANNEL (ABOVE CENTRAL AVENUE)	6.16	Miles

Nutrient/Effect	Impaired Waterbody/Segment	Extent	
Org. enrichment/Low D.O.	CONEJO CREEK REACH 1 (CONFL CALL TO SANTA ROSA RD)	5.8	Miles
Org. enrichment/Low D.O.	CONEJO CREEK REACH 2 (SANTA ROSA RD TO THO. OAKS CITY LIMIT)	2.67	Miles
Org. enrichment/Low D.O.	CONEJO CREEK REACH 3 (THOUSAND OAKS CITY LIMIT TO LYNN RD.)	5.6	Miles
Org. enrichment/Low D.O.	CONEJO CREEK REACH 4 (ABOVE LYNN RD.)	4.98	Miles

1.3 ENVIRONMENTAL SETTING

Calleguas Creek and its tributaries are located in southeast Ventura County and a small portion of western Los Angeles County. Calleguas Creek drains an area of approximately 343 square miles from the Santa Susana Pass in the east to Mugu Lagoon in the southwest. The main surface water system drains from the mountains in the northeast part of the watershed toward the southwest where it flows through the Oxnard Plain before emptying into the Pacific Ocean through Mugu Lagoon. The watershed, which is elongated along an east-west axis, is about thirty miles long and fourteen miles wide.

The Santa Susana Mountains, South Mountain, and Oak Ridge form the northern boundary of the watershed; the southern boundary is formed by the Simi Hills and Santa Monica Mountains. The upper watershed is characterized by two subwatersheds, the northern and southern subwatersheds. The northern subwatershed is drained by Arroyo Simi and its tributaries, to Arroyo Las Posas which is tributary to Calleguas Creek. There is significant groundwater recharge by the Arroyo Las Posas which is frequently dry during dry weather. The southern subwatershed is drained by Conejo Creek and its tributaries: Arroyo Santa Rosa, North Fork Conejo Creek and South Fork Conejo Creek. The lower watershed is drained by Conejo Creek, Beardsley Channel, Revolon Slough, Calleguas Creek and, and several minor tributaries such as agricultural drains in the Oxnard plain.

Land uses in the Calleguas Creek watershed include agriculture, high and low density residential, commercial, industrial, open space, and a Naval Air Base located around Mugu Lagoon. The watershed includes the cities of Simi Valley, Moorpark, Thousand Oaks, and Camarillo. Most of the agriculture is located in the middle and lower watershed with the major urban areas (Thousand Oaks and Simi Valley) located in the upper watershed. The current land use in the watershed is approximately 26% agriculture, 24% urban, and 50% open space. Patches of high quality riparian habitat are present along the length of Calleguas Creek and its tributaries.

1.3.1 Northern Watershed

The northern portion of the watershed is drained by the Arroyo Las Posas and the Arroyo Simi, which is tributary to the Arroyo Las Posas. The northern part of the watershed system originates in the Simi Valley and surrounding foothills. The surface flow comes from the headwaters at Santa Susanna pass (upper parts of Reach 7) and Tapo Canyon (Reach 8). In the Simi basin, the stream channel commonly is not dry owing to discharges of treated municipal wastewater from the Simi Valley Water Quality Control Facility (WQCF) and groundwater discharges from perched shallow aquifers. Some groundwater is pumped for dewatering, and discharged under permit to the stream. A POTW, the Simi Valley WQCF, discharges treated municipal wastewater in Reach 7 below the Reach 8 confluence. Downstream of Hitch Boulevard, Arroyo Las Posas passes through agricultural fields and orchards in a primarily natural channel. During most of the year, at the point where the channel reaches Seminary Road, the surface water flow has been lost to groundwater percolation and evaporation. During and immediately following significant rains, surface flows in the Arroyo Las Posas discharges to Calleguas Creek.

Arroyo Simi and Arroyo Las Posas flow through the cities of Simi Valley and Moorpark and join with Calleguas Creek near Camarillo. Upstream of Simi Valley, the creek is unlined and passes through open space and recreational areas. Through the city, the creek flows through concrete lined or rip-rapped channels. Between Simi Valley and Moorpark, a distance of approximately 7 miles, the creek is unlined and without rip-rap. From the edge of Moorpark to Hitch Boulevard, the creek is once again rip-rapped on the sides with a soft bottom throughout most of the channel, but in some areas, such as under bridges, the bottom is covered with concrete and rip rap.

Arroyo Las Posas typically is dry except during wet-season storm discharges. Groundwater basins in this area have long been in overdraft, so surface flow during the dry weather season typically is absorbed as groundwater recharge.

1.3.2 Southern Watershed

- Conejo Creek
  Conejo Creek drains the southern portion of the watershed. This area supports significant residential land uses, especially in the Thousand Oaks area drained by the South Fork of Conejo Creek. The area also supports significant agricultural land uses, especially in the Santa Rosa Valley area, downstream of the confluence of the North and South Forks of Conejo Creek and the area drained by the Arroyo Santa Rosa. During non-storm periods, flow in Conejo Creek is mostly comprised of treated municipal wastewater. Upstream of the wastewater discharges, pumped groundwater and urban non-storm runoff sustain a small baseline flow.

- Arroyo Santa Rosa Channel
  The Arroyo Santa Rosa channel is a natural channel for most of its length with portions of rip-rap and concrete lining along the sides and bottom of the channel in the vicinity of homes (such as near Las Posas Road). During periods of low flow, it has a dry reach before its connection to the Arroyo Conejo. The Arroyo Conejo runs through Thousand Oaks and has three branches, the main fork, the north fork, and the south fork. The main fork of the Arroyo Conejo runs

underground for most of its length. The portions that are above ground are concrete lined until the creek enters Hill Canyon on the western side of the city and converges with the south fork. The south fork runs through the southern and western portions of Thousand Oaks. For most of its length, the south fork flows underground or through concrete lined channels. The north fork runs through Thousand Oaks upstream of the Hill Canyon treatment plant. The channel is concrete lined for the portion that runs through the city, but becomes unlined when it nears the treatment plant. The main fork and the north fork converge approximately 0.4 miles downstream of the Hill Canyon Water Reclamation Plant. The Arroyo Conejo then merges with the Arroyo Santa Rosa to form Conejo Creek. Conejo Creek flows downstream approximately 7.5 miles before its confluence with Calleguas Creek. For most of the length of the Conejo and Calleguas Creeks, the sides of the channel are rip rapped and the bottom is unlined.

- Revolon Slough

  Revolon Slough drains the agricultural land in the western portion of the watershed. The slough does not pass through any urban areas, but does receive drainage from tributaries that drain urban areas. Revelon Slough starts as Beardsley Wash in the hills north of Camarillo. The wash is a rip rapped channel for most of its length and combines with Revolon Slough at Central Avenue in Camarillo. The slough is concrete lined just upstream of Central Avenue and remains lined for approximately 4 miles to Wood Road. From there, the slough is soft-bottomed with rip-rapped sides. The lower mile to mile and a half of the slough to above Las Posas Road appear to be tidally influenced by inflows from Mugu Lagoon. In addition to Revolon Slough, a number of agricultural drains (Oxnard Drain, Mugu Drain, and Duck Pond Drain) serve as conveyances for agricultural and industrial drainage water to the Calleguas Creek estuary and Mugu Lagoon.

- Mugu Lagoon

Mugu Lagoon, an estuary at the mouth of Calleguas Creek, supports a diverse wildlife population including migratory birds and endangered species. This area is affected by military land uses of the Point Mugu Naval Air Weapons Station and substantial agricultural activities in the Oxnard Plain. The Oxnard Plain, drained by shallow tributaries and the Calleguas Creek main stem, is an area of intensive agricultural land use and irrigated by pumping from deep local aquifers.

The lagoon consists of approximately 287 acres of open water, 128 acres of tidal flats, 40 acres of tidal creeks, 944 acres of tidal marsh and 77 acres of salt pan (California Resources Agency, 1997). It is comprised of a central basin into which flows from Revolon Slough and Calleguas Creek enter and two arms (eastern and western) which receive some drainage from agricultural and industrial drains. The salinity in the lagoon is generally between 31 and 33 parts per thousand (ppt) (Granade, 2001). The central basin of the lagoon has a maximum tidal range of approximately -1.1 to 7 feet (as compared to mean sea level) with smaller ranges in the two arms. The western arm of the lagoon receives less tidal volume because of a bridge culvert that restricts the flows in that area. The velocity of water traveling through the mouth of the lagoon is approximately 5-6 knots, which is a high velocity for a lagoon (Grigorian, 2001). The mouth of the lagoon never closes, apparently as a result of a large canyon present at the mouth of Calleguas Creek. The canyon prevents ocean sand from building up to a high enough level to close the mouth and likely accounts for the high velocities in the lagoon (Grigorian, 2001).

1.3.3 Climate and Hydrology

The climate in the watershed is typical of the southern California coastal region. Summers are relatively warm and dry and winters are mild and wet. Eighty-five percent of the rainfall occurs between November and March with most of the precipitation occurring during just a few major storms. Annual rainfall in Ventura County averages 15 inches and varies from 13 inches on the Oxnard Plain to a maximum of 20 inches in the higher elevations (USDA, 1995).

About 15 to 20 discrete storm events occur per year concentrated in the wet-weather months, producing runoff of a duration from one-half day to several days (USGS, 2000). Discharge during runoff from storm events is commonly 10 to 100 times greater than at other times. Storm events and the resulting high stream flows are highly seasonal, grouped heavily in the months of November through February, with an occasional major storm as early as September and as late as April. Rainfall is rare in other months, and major storm flows historically have not been observed outside the wet-weather season. The watershed is dependent to a significant extent on supplies of imported water.

1.3.4 Surface Waters

The main surface water system drains from the mountains toward the southwest, where it flows through the Oxnard Plain before emptying to the Pacific Ocean through Mugu Lagoon. Stream flow in the upper portion of the watershed is minimal, except during and immediately after rainfall. Just below the cities of Simi Valley and Thousand Oaks, the major potion of the flow is extracted groundwater and treated municipal wastewater. A key feature of the Calleguas Creek watershed in terms of developing TMDLs is that Revolon Slough is a parallel stream to Calleguas Creek and does not receive flow from Calleguas Creek. The flow in Revolon Slough is comprised mostly of agricultural drainage and extracted groundwater.

Flow in Calleguas Creek is described as storm peaking and is typical of smaller watersheds in coastal southern California. Dry-weather flow in Calleguas Creek and its tributaries is composed mostly of POTW effluent, groundwater discharge from shallow surface aquifers, groundwater extraction for construction dewatering or remediation of contaminated aquifers, and urban and agricultural runoff. In the upper reaches of the watershed, groundwater seepage into the surface water provides some flow.

The following sections describe the typical conditions within the key reaches, and the manner in which water moves into and among reaches of the watershed under non-storm conditions.

1.3.5 Surface Water/Groundwater Interactions

The Calleguas Creek watershed is characterized by complex and varied interrelationships between surface water and groundwater, including:

- Surface water recharge of deep aquifers with large storage capacities.
- Surface water recharge of shallow or perched aquifers that are separated from deeper aquifers by clay layers. Water in those shallow or perched aquifers is in hydraulic communication with surface water.
- Groundwater discharges produce surface flow which is then recharged into the aquifers downstream. The recharged groundwater may travel along the stream as subsurface flow from which it may discharge again to appear as surface flow.

The shallow aquifers are of particular interest because their water is in close connection with surface waters. Shallow aquifers located upstream of Simi Valley, Hill Canyon, and downstream of Camarillo POTWs discharge groundwater to the surface (without pumping), in varying amounts depending on the depth of the water table. The prominent reaches where shallow groundwater is immediately pumped for agricultural irrigation include the Arroyo Las Posas and Santa Rosa Valley. In the lower Santa Rosa Valley the creek is augmented by rising groundwater from the shallow aquifer system, as well as by urban non-storm runoff and subsurface flows. The groundwater characterization data in these areas are sparse. However, the Santa Rosa Valley is characterized by a large number of septic systems that typically discharge significant concentrations of nitrate to groundwater.

Downstream from the Santa Rosa Valley, the surface flow receives treated municipal wastewater discharged by the Camarillo Wastewater Treatment Plant (WWTP) and some portion of the flow is lost to groundwater recharge in this area.

The Camrosa Wastewater Reclamation Facility (WRF) is located in Calleguas Creek (Reach 3) just downstream of its confluence with the Conejo Creek and discharges to groundwater via a percolation pond during dry weather. The shallow aquifer is separated from deep underlying aquifers by shallow clay layers and perched shallow groundwater and the water quality in the shallow aquifer exhibits elevated levels of nutrients.

1.3.6 Anthropogenic Alterations

Historically, the Oxnard Plain served as the flood plain for Calleguas Creek. Starting in the 1850's, agriculture began to be practiced extensively in the watershed. By 1889, a straight channel from the area near the present day location of Highway 101 to the Conejo Creek confluence had been created for Calleguas Creek. In the 1920's, levees were built to channelize flow directly into Mugu Lagoon (USDA, 1995). Increased agricultural and urban land uses in the watershed resulted in continued channelization of the creek to the current channel system.

Historically, Calleguas Creek was an ephemeral creek flowing only during the wet season. The cities of Simi Valley, Moorpark, Camarillo, and Thousand Oaks experienced rapid residential and commercial development since the 1960s. In the early 70's, State Water Project supplies began being delivered to the watershed. In 1957, the Camarillo Water Reclamation Plant came online, followed by the Hill Canyon Treatment Plant in Thousand Oaks in 1961. Increasing volumes of discharges from these POTWs eventually caused the Conejo/Calleguas system to become a perennial stream by 1972 (SWRCB, 1997). When the Simi Valley Water Reclamation Facility began discharging in the early 1970's, the Arroyo Simi/Arroyo Las Posas became a perennial stream downstream of the plant to Seminary Road in Camarillo. However, surface flows from the Arroyo Simi/Arroyo Las Posas do not connect with surface flows in the Conejo Creek/Calleguas system, except during and immediately following storm events.

1.3.7 Flow Diversion Project

The Conejo Creek Diversion project in the Calleguas Creek watershed, when operational, will divert the majority of flow in Conejo Creek to agricultural uses in the Pleasant Valley area. The diversion project will be constructed approximately 7 miles downstream from the Hill Canyon Wastewater Treatment Facility (WTF). The water rights application allows the diversion of an amount equal to Hill Canyon's effluent minus 4 cfs for instream uses and channel losses. An additional amount of water equal to the flow contributed by use of imported water in the region (estimated at 4 cfs) may be diverted when at least 6 cfs of water will remain in the stream downstream of the diversion point (SWRCB, 1997). Natural flows due to precipitation will not be diverted. As a result of this project, flows in the lower reach of Conejo Creek could be less than half of the current flows in the creek.

1.3.8 Reach Designations

Table 2 summarizes the reach descriptions of Calleguas Creek used in this TMDL. These reach designations provide greater detail than the designations in the current *Basin Plan*, and are developed for purposes of this TMDL. The reach revisions may provide an appropriate analytical tool for future analyses in the watershed. At this time, though, the reach revisions are not regulatory and do not alter water quality objectives for the reaches in the existing *Basin Plan*. For this TMDL, Reach 7, Arroyo Simi has been divided into two segments at the outfall of the Simi Valley WQCF.

TABLE 2 DESCRIPTION OF CALLEGUAS CREEK REACHES

Previous Reach No.	Revised Reach No.	Reach Name	Geographic Description	Notes: Hydrology, land uses, etc.
1	1	Mugu Lagoon	Lagoon fed by Calleguas Creek	Estuarine; brackish, contiguous with Pacific Ocean
1	2	Calleguas Creek South	Downstream (south) of Potrero Rd	Tidal influence; concrete lined; tile drains; Oxnard Plain
2	3	Calleguas Creek North	Potrero Rd. upstream to confluence Conejo Creek	Concrete lined ; no tidal influence; Agriculture tile drains; Pleasant Valley Basin. Camrosa WRP discharges to percolation ponds.
2	4	Revolon Slough	Revolon Slough from confluence with Calleguas Creek to Central Ave	Concrete lined ; tile drains; Oxnard Plain; tidal influence
2	5	Beardsley Channel	Revolon Slough upstream of Central Ave.	Concrete lined ; tile drains; Oxnard Plain
2	6	Arroyo Las Posas	Confluence with Calleguas Creek to Hitch Road	Ventura Co. POTW discharge at Moorpark to percolation ponds; discharges enter shallow aquifer; dry at Calleguas confluence
2	7A	Arroyo Simi	End of Arroyo Las Posas (Hitch Rd) to outfall of Simi Valley POTW.	Simi Valley WQCF discharge; discharges from shallow aquifers.
2	7B	Arroyo Simi	Simi Valley WQCF to headwaters in Simi Valley	Pumped GW; GW discharges from shallow aquifers.
2	8	Tapo Canyon	Confluence w/ Arroyo Simi up Tapo Cyn to headwaters	Origin near gravel mine, used by nursery, ends in residences.
2	9A	Conejo Creek	Extends from the confluence with Arroyo Santa Rosa downstream to the Camrosa Diversion	Pleasant Valley Groundwater Basin contains both confined and unconfined perched aquifers. Groundwater and surface water used for agriculture.
2	9B	Conejo Creek	Extends from Camrosa Diversion to confluence with Calleguas Creek.	Pleasant Valley Groundwater Basin contains both confined and unconfined perched aquifers. Both are designated as AGR. Camarillo WTP discharges to percolation ponds near downstream end.

Previous Reach No.	Revised Reach No.	Reach Name	Geographic Description	Notes: Hydrology, land uses, etc.
2	10	Hill Canyon reach of Conejo Creek	Confluence w/ Arroyo Santa Rosa to confluence w/ N. Fork; and N. Fork to just above Hill Canyon WTF	Hill Canyon WTF; stream receives N. Fork Conejo Creek surface water.
2	11	Arroyo Santa Rosa	Confluence w/ Conejo Creek to headwaters	Olsen Rd. WRP; dry before Calleguas Ck confluence except during storm flow.
2	12	North Fork Conejo Creek	Confluence w/Conejo Creek to headwaters	
2	13	Arroyo Conejo (South Fork Conejo Creek)	Confluence w/ N. Fork to headwaters —two channels	City of Thousand Oaks; pumped/treated GW

2 TMDL PROCESS

This section discusses the elements of a TMDL prescribed by the Clean Water Act. It includes problem identification, development of numeric targets, source assessment, linkage analysis, allocations, critical conditions and seasonality, margin of safety and future growth.

2.1 PROBLEM IDENTIFICATION.

This subsection provides an overview of the impairments of Calleguas Creek by nutrients and their effects. This subsection first reviews Water Quality Standards, the benchmark for determining impairments, including the beneficial uses of Calleguas Creek and its tributaries, and the numeric and narrative standards for nutrients and their related effects. It then provides an overview of the data used by the Regional Board to identify the reaches of Calleguas Creek that are impaired for nitrogen and related effects and included on the 303(d) list.

2.1.1 Water Quality Standards

In California water quality standards consist of: 1) beneficial uses, 2) narrative and numeric objectives, and 3) an antidegradation policy. Beneficial uses are defined by the Regional Board in its 1994 Water Quality Control Plans (*Basin Plan*). Numeric and narrative objectives for most conventional water quality parameters are also defined in the *Basin Plan*, while numeric objectives for toxics are established by the California Toxics Rule (40 CFR 131.38). The antidegradation policy is established in federal regulations (40 CFR 131.12) defined by the State Water Resources Control Board (State Board) in Resolution No. 68-16.

2.1.1.1 Beneficial Uses

The *Basin Plan* for the Los Angeles Regional Board defines 11 beneficial uses for Calleguas Creek (Tables 3A and 3B). These uses include existing (E), potential (P) or intermittent (I) uses. All beneficial uses must be protected. However the beneficial uses that are most sensitive to nitrogen and related effects are WARM, WILD, GWR, REC-1, and REC-2. These beneficial uses are defined below and will be the focus of the following discussion. Table 3 summarizes the beneficial uses for Calleguas Creek currently designated by the *Basin Plan*.

The use designation for warm water fish (WARM) habitat exists over much of the Calleguas Creek and its tributaries. The WARM designation applies as a potential use to the remaining listed tributaries. The cold water fisheries designated use (COLD) applies only to Calleguas Creek and does not apply to the tributaries of Calleguas Creek or any of the tributaries listed for nutrients or their related effects. The Wildlife use designation (WILD) is for the protection of fish and wildlife. This use applies to the Calleguas Creek and its tributaries. Water quality standards developed for the protection of fish and wildlife are applicable to the reaches with the WARM and WILD designations.

The municipal supply (MUN) use designation applies to Lake Bard and all ground waters of the Calleguas Creek watershed.[1] The ground water recharge (GWR) use designation applies to Calleguas Creek, Revolon Slough, Arroyo Las Posas, and the North Fork of the Arroyo Conejo. The ground water recharge use applies intermittently to the other reaches in the Calleguas Creek watershed.

Recreational uses for secondary contact (REC2) apply to almost all the listed Calleguas Creek segments and tributaries as either existing, potential or intermittent. Standards designed to protect human health (e.g., bacterial standards) and the aesthetic qualities of the resource (e.g., visual, tastes and odors) are appropriate to protect recreational uses of Calleguas Creek. Water contact recreation (REC-1) is designated as potential beneficial use in the Basin Plan for many of the reaches of Calleguas Creek.

Plant and algae growth can have impacts on recreation/aesthetics, drinking water supply, industrial and agricultural operations, and aquatic life beneficial uses. Recreational and aesthetic impacts can include reduced water clarity by sloughed material, interference with swimming and other recreation, fouling anglers' nets, floating mats, slippery beds that make wading dangerous, and impairment of aesthetic enjoyment. Plant and algae growth may impact water supply systems by blocking intake screens and filters and, by production of tastes and odors in the water. It can also impact industrial and agricultural operations by blocking or clogging screens, filters, and drainage channels. Plant growth can also impact the aquatic life support use by contributing to low dissolved oxygen concentrations from the nighttime respiration of large populations of aquatic plants and algae or by the decay of plant

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[1] Other waterbodies within the watershed have a conditional designation for MUN. These waterbodies are indicated with an asterisk in the *Basin Plan*. However, conditional designations are not recognized are under federal law and are not water quality standards subject to enforcement at this time. (See Letter from Alexis Strauss [USEPA] to Celeste Cantú [State Board], Feb. 15, 2002.)

matter (EPA, 1999b).

Beneficial uses that algae are most likely to affect in this watershed are aquatic life habitat (WARM) and recreational use (REC-1 and REC-2). Negative effects on aquatic life would result from low dissolved oxygen levels caused by excessive algal blooms, which would also be an aesthetic impairment to recreational use.

TABLE 3A BENEFICIAL USES OF CALLEGUAS CREEK

Reach	Hydro. Unit No.	MUN[1]	IND	PROC	AGR	GWR	FRSH	NAV	REC1	REC2	COM
Mugu Lagoon	403.11							E	P	E	E
Calleguas Creek Estuary	403.11							P	P	E	E
Calleguas Creek	403.11				E	E	E		E	E	
Calleguas Creek	403.12		E	E	E	E			Eq	E	
Revolon Slough	403.11		P		E	E			E	E	
Beardsley Wash	403.61						E		E	E	
Conejo Creek	403.12		E	E	E	E			Eq	E	
Conejo Creek	403.63					I	I		I	I	
Arroyo Conejo	403.64					I	I		I	I	
Arroyo Conejo	403.68					I	I		I	I	
Arroyo Santa Rosa	403.63					I	I		I	I	
Arroyo Santa Rosa	403.65					I	I		I	I	
North Fork Arroyo Conejo	403.64				E	E			E	E	
Arroyo Las Posas	403.12		P	P	P	P	E		E	E	
Arroyo Las Posas	403.62		P	P	P	P	E	E	E	E	
Arroyo Simi	403.62		I			I	I		I	I	
Arroyo Simi	403.67		I			I	I		I	I	
Tapo Canyon Creek	403.66					P	P		I	I	
Tapo Canyon Creek	403.67					P	P		I	I	
Gillibrand Canyon Creek	403.66					I	I		I	I	
Gillibrand Canyon Creek	403.67					I			I	I	
Lake Bard	403.67	E	E	E	E	P			P	E	

[1] As noted in the prior footnote, the existing *Basin Plan* contains conditional designation of potential MUN for many waterbodies in this watershed; however, this table only reflects current, lawfully enforceable designations.

TABLE 3B BENEFICIAL USES OF CALLEGUAS CREEK

Reach	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET
Mugu Lagoon			E	E	E	E	E	E	E	E	E
Calleguas Creek Estuary			E		E		E	E	E		E
Calleguas Creek	E	E			E		Ep				E
Calleguas Creek	E				E						
Revolon Slough	E				E						E
Beardsley Wash	E				E						
Conejo Creek	E				E						
Conejo Creek	I				E				E		
Arroyo Conejo	I				E		E				
Arroyo Conejo	I				E						
Arroyo Santa Rosa	I				E						
Arroyo Santa Rosa	I				E						
North Fork Arroyo Conejo	E				E				E		
Arroyo Las Posas	E	P			E						
Arroyo Las Posas	E	P			E						
Arroyo Simi	I				E		E				
Arroyo Simi	I				E						
Tapo Canyon Creek	I				E						
Tapo Canyon Creek											
	I				E						
Gillibrand Canyon Creek	I				E						
Gillibrand Canyon Creek	I				E						
Lake Bard	E				E						

E: Existing beneficial use P: Potential beneficial use I: Intermittent beneficial use p: Habitat of the Clapper Rail. q: Whenever flows are suitable

2.1.1.2 Water Quality Objectives

This section describes both numeric and narrative objectives prescribed in the *Basin Plan* for ammonia, nitrate, dissolved oxygen and algae. These objectives, along with the beneficial uses set forth above, provide the basis for establishing targets for the TMDL. Although the TMDL focuses on the nitrogen compounds, the scientific analysis indicates that addressing the nitrogen compounds may attain objectives relative to dissolved oxygen and algae.

2.1.1.2.1 Ammonia

The *Basin Plan* objectives for ammonia currently are based on "Ambient Water Quality Criteria for Ammonia – 1984," which contains criteria for protection of freshwater aquatic life. In 1999 EPA revised its recommended values for the Criteria Continuous Concentration (CCC) through a memorandum "Revised Tables for Freshwater Ammonia Concentrations." The chronic criteria were raised slightly because one of the chronic toxicity tests involving white sucker used in the 1984 criteria were no longer considered valid.

The existing *Basin Plan* provides the following objective for ammonia:

The neutral, un-ionized ammonia species (NH_3) is highly toxic to fish and other aquatic life. The ratio of toxic NH_3 to total ammonia ($NH_4^+ + NH_3$) is primarily a function of pH, but is also affected by temperature and other factors. Additional impacts can occur as the oxidation of ammonia lowers the dissolved oxygen content of the water, further stressing aquatic organisms. Ammonia also combines with chlorine (often both are present) to form chloramines – persistent toxic compounds that extend the effects of ammonia and chlorine downstream.

Oxidation of ammonia to nitrate may lead to groundwater impacts in the area of recharge.

In order to protect aquatic life, ammonia concentrations in receiving waters shall not exceed the values listed for the corresponding in-stream conditions in Tables 3-1 to 3-4 [of the Basin Plan].

In order to protect underlying groundwater basins, ammonia shall not be present at levels that, when oxidized to nitrate, pose a threat to groundwater.

The EPA's new 1999 criteria reflect research and data analyzed since 1985, and represent a revision of several elements in the 1984 guidance, including the relationship between ammonia toxicity, pH and temperature, and the recognition of increased sensitivity of early life stage forms of fish to ammonia toxicity. The 1984 criteria were based on un-ionized ammonia (NH_3), while the 1999 criteria are expressed only as total (un-ionized plus ionized or NH_3 + NH_4^+) ammonia. The criteria apply to freshwater and do not impact the Ammonia Water Quality Objectives contained in the California Ocean Plan.

Chronic values presented in the updated criteria were derived based on regression analysis. In the past, hypothesis testing was used whereby the chronic value was derived by calculating the geometric mean of the "no observed effects concentration" (NOEC) and the "lowest observed effects concentration" (LOEC). Regression analysis is the preferred method because it is more reflective of the magnitude of the toxic response. The results of hypothesis testing vary depending on the values tested and the variability of the database.

The most significant differences in the 1999 U.S. EPA guidance for ammonia are:

- Acute criteria are no longer temperature-dependent but remain dependent on pH and fish species present.
- A greater recognition of the temperature dependence of the chronic criteria, especially at low temperatures.
- An Early Life Stage (ELS) chronic criteria was introduced.
- Chronic criteria are no longer dependent on the presence or absence of specified fish species, but remain dependent on pH and temperature.
- A 30-day averaging period for the ammonia chronic criteria replaced the 4-day averaging period.

Under the 1984 guidance, the acute criteria were dependent on pH, temperature, and the presence or absence of salmonids. Under the updated guidance, the acute criteria are dependent on pH and fish species, but not temperature.

The 1984 chronic criteria were dependent mainly on pH and there was no temperature dependency below 20 degrees. The updated chronic criteria are dependent on pH and temperature. At lower temperatures, the chronic criteria also are dependent on the presence or absence of early life stages of fish (ELS), regardless of species. Another significant revision to the 1999 Update is EPA's recommendation of 30 days as the averaging period for the chronic criteria instead of 4 days. The averaging period has been extended because the most sensitive test species used, fathead minnow (Pimephales promelas) and Muscullum transversum (a fingernail clam) show their sensitivity after long periods of exposure.

The revised objectives are not yet approved by the Office of Administrative Law (OAL), but that the TMDL has been developed to be consistent with the updated objectives. Further, the Regional Board's resolution adopting the TMDL will specify that the TMDL will take effect following the approval of the revised criteria by OAL.

CALCULATION OF AMMONIA OBJECTIVE AS REFLECTED IN THE APRIL 25, 2002, BASIN PLAN AMENDMENT APPROVED BY THE REGIONAL BOARD

1 The one-hour average concentration of total ammonia as nitrogen (in mg N/L) does not exceed (more than once every three years on average) the CMC (acute criteria) calculated using the following equations.

Where salmonid fish are present:

$$CMC = \frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}} \qquad \text{(Equation 1a)}$$

Or where salmonid fish are not present:

$$CMC = \frac{0.411}{1 + 10^{7.204-pH}} + \frac{58.4}{1 + 10^{pH-7.204}} \quad \text{.......(Equation 1b)}$$

2 The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed (more than once every three years on the average) the CCC (chronic criteria) calculated using the following equations.

Where early life stage fish are present:

$$CCC = \left(\frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}} \right) * MIN\left(2.85,\ 1.45 * 10^{0.028*(25-T)}\right) \quad \text{.......(Equation 2a)}$$

where MIN indicates use of the lesser of the two values contained within the parentheses.

Or where early life stage fish are not present:

$$CCC = \left(\frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}} \right) * 1.45 * 10^{0.028*(25-MAX(T,7))} \quad \text{.......(Equation 2b)}$$

where MAX indicates use of the greater of the two values contained within the parentheses and,
T = temperature expressed in °C.

3 In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the CCC.

2.1.1.2.2 Oxidized Nitrogen

The *Basin Plan* establishes numeric water quality objectives for nitrogen, expressed as nitrate-nitrogen plus nitrite-nitrogen, for Calleguas Creek and some of its tributary reaches. The *Basin Plan* prescribes water quality objectives for reaches above Potrero Road of 10 mg/L nitrogen. Below Potrero Road, the water quality objective for nitrogen is based on the objective of the underlying aquifer of 10 mg/L. A site-specific objective to protect the groundwater recharge beneficial use below Portrero Road has not been determined.

The *Basin Plan* specifies that "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses." The *Basin Plan* also recognizes that such excessive growth can cause water quality problems (e.g., high pH) and aesthetic problems (e.g., odor, scum). Oxidized nitrogen promotes the growth of algae and is considered a biostimulatory substance subject to the narrative objective. The Implementation Plan includes additional studies to determine if background targets for oxidized nitrogen are required to meet the biostimulatory narrative objective. In the interim, numeric targets under this TMDL are derived from the numeric objective for nitrogen.

For purposes of this TMDL, the Regional Board proposes a numeric target of oxidized nitrogen that is equal to existing objectives in the *Basin Plan*. Table 4 summarizes the oxidized nitrogen targets for the Calleguas watershed.

TABLE 4 OXIDIZED NITROGEN TARGETS

Nitrate-N	Nitrite-N	Nitrate-N + Nitrite-N
10 mg/L	1 mg/L	10 mg/L

2.1.1.2.3 Dissolved Oxygen (DO)

The *Basin Plan* objective for DO states (RWQCB, 1994, p.3-11):

"Adequate dissolved oxygen levels are required to support aquatic life. Depression of dissolved oxygen can lead to anaerobic conditions resulting in odors or, in extreme cases, in fish kills. Dissolved oxygen requirements are dependent on the beneficial uses of the waterbody. *At a minimum (see specifics below), the mean annual dissolved oxygen concentration of all waters shall be greater than 7 mg/L, and no single determination shall be less than 5.0 mg/L, except when natural conditions cause lesser concentrations."*

The present of nitrogen compounds in waterbody has the potential to lower DO levels. Initially, the Regional Board is adopting numeric targets for nitrogen compounds that will likely have a positive affect on DO. However, the TMDL's impact on DO will be evaluated during implementation and if the TMDL's nitrogen compound allocations are not achieving water quality standards for DO, then the TMDL will be reopened and revised accordingly.

2.1.1.2.4 Algae

The *Basin Plan* standard for algae is based on the narrative objective for biostimulatory substances: biostimulatory substances should not be present in concentrations that promote growth to the extent that such growth causes nuisance or adversely affects beneficial uses. The main impacts that algae could have in this watershed include algal mats and depressed DO levels.

A numeric target for nuisance algae of 100 to 200 mg/m^2 for chlorophyll a is suggested in technical literature (Biggs, 2000; Dodds and Welch, 2000; Dodds et al., 1997). Although algae has been observed in Calleguas Creek, its tributaries, and Mugu lagoon, there are no available data on chlorophyll a concentrations in Calleguas Creek and the appropriateness of these values to the Calleguas Creek system is unknown. Algal biomass and DO concentrations will be measured along with measurements for scum and odors as part of the TMDL monitoring plan. It is anticipated that reductions in nitrogen compounds implemented as part of this TMDL may reduce algal biomass. The Implementation Plan includes special studies to evaluate algae conditions and impairments of Calleguas

Creek, and development of numeric targets to attain the water quality objective for biostimulatory substances.

2.1.1.3 Antidegradation

State Board Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Water in California, known as the "Antidegradation Policy," protects surface and ground waters from degradation. Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12). The proposed TMDL will not lower water quality, and will in fact improve water quality as it is designed to achieve compliance with existing water quality standards.

2.1.2 Basis of Listing

Calleguas Creek was included on California's Clean Water Act (CWA) Section 303(d) list in 1998 as water-quality-limited due to ammonia, nitrite-N and nitrate-N, dissolved oxygen and algae. The basis for each constituent's listing and the specific reach of Calleguas Creek is summarized below.

2.1.2.1 Ammonia

Ammonia is included on the 1998 303(d) list as impairing various reaches of Calleguas Creek, including Arroyo Simi, Arroyo Las Posas, Arroyo Conejo, Conejo Creek, and Calleguas Creek. The 303(d) listing for ammonia was based primarily on the data collected by the POTWs under their

NPDES permits and Regional Board monitoring.

Monitoring conducted subsequent to the 1998 303(d) listing, including POTW effluent monitoring, the Calleguas Creek Characterization Study (CCCS) and the Thousand Oaks Study, has confirmed the basis for most of the ammonia listings. The listing for Conejo Creek R4 (above Lynn Rd.) (where no data were collected) resulted from all the reaches in the Conejo Creek system being combined into one listing in 1996 and then separated into different reaches in 1998. Monitoring data from the CCCS and Thousand Oaks Study indicate that ammonia objectives are not exceeded upstream of the Hill Canyon Wastewater Treatment Plant (WTP). Samples collected under these programs exceeded ammonia objectives in reaches below POTWs. Upstream of the treatment plants and on Revolon Slough, where there are no POTW discharges, ammonia objectives were not exceeded.

Table 5 displays data on ammonia for reaches in the Calleguas Creek Watershed. These data were compared to the ammonia objective in the Basin Plan after adjusting for pH and temperature. The adjustments were made using the pH and temperature data collected concomitantly with the ammonia data. Most of these data exceeded the 30-day chronic objective (bolded in Table 5). A subset of these values also exceeds the 1-hour acute objective (underlined in Table 5). For the purpose of the 303(d) listing, a reach was considered to be non-supporting if greater than 10% of the samples exceeded the criterion.

TABLE 5 AMMONIA CONCENTRATION (MG/L) IN CALLEGUAS CREEK

Reach	Number of Stations	Number of Samples	Mean (mg/L-N)	Percent above Objective	Reach Listed?
Calleguas Creek R1 (Estuary to Broome Ranch Rd.)	3	28	**2.66**	43%	Yes
Calleguas Creek R2 (Broome Ranch Rd. to Portrero Rd.)	2	25	**3.54**	52%	Yes
Calleguas Creek R3 (Portrero to Lewis/Somis Rd.)	6	59	**4.64**	69%	No
Conejo Creek R1 (Confluence Calleguas to Santa Rosa Rd.)	8	60	**6.89**	88%	Yes
Conejo Creek R2 (Santa Rosa Rd. to T.O. City Limit)	3	26	**9.21**	81%	Yes
Conejo Creek R3 (T.O. City Limit to Lynn Rd.)	5	58	**6.49**	57%	Yes
Conejo Creek R4 (Above Lynn Rd.)		No data			Yes
Arroyo Santa Rosa Tributary		No data			No Listings
Arroyo Conejo North Fork	6	40	**4.24**	23%	Yes
Arroyo Las Posas R1 and R2 (Lewis-Somis Rd. to Moorpark Fwy)	5	4	**3.95**	100%	Yes
Arroyo Simi R1 (Moorpark Fwy to Brea Canyon)	9	7	**6.24**	57%	Yes
Arroyo Simi R2 (Above Brea Canyon)	3	2	0.09	0%	No
Beardsley Wash/Channel	3	1	0.6	0%	No
Revolon Slough	7	12	0.52	0%	No
Duck Pond Ag Drain	1	No data			No
Mugu Lagoon		No data			No

The POTW effluent data also indicates that the several of the POTWs are a significant source of ammonia to Calleguas Creek (See Section 3 for a more detailed discussion on sources). The monitoring conducted by the POTWs during the Calleguas Creek Characterization Study (CCCS) and the Thousand Oaks Characterization Study (TOCS) subsequent to the 1996 and 1998 303(d) listing has confirmed the basics for most of these listing. Samples collected under these program exceeded ammonia objectives in reaches below POTWs. Effluent concentrations tend to be about 10-times greater than the chronic standard and are often greater than the acute standard. Upstream of the treatment plants and in Revolon Slough, where there are no POTW discharges, ammonia objectives were not exceeded

2.1.2.2 Oxidized Nitrogen

Nitrate-N + nitrite-N and nitrogen are listed on the 1998 303(d) list as impairing various reaches of the Calleguas Creek watershed. Background information developed for the 1996 303(d) list indicates that nitrate-N + nitrite-N is listed as impairing ground water recharge beneficial uses in Revolon Slough, and Calleguas Creek; and Arroyo Las Posas. Nitrogen compounds are listed as impairing aquatic life beneficial uses in Beardsley Channel, Revolon Slough, Calleguas Creek, Mugu Drain, Oxnard Drain #3, and Mugu Lagoon (RWQCB, 1997a). The 303(d) listing was based primarily on the data collected by the POTWs under their NPDES permits, the Thousand Oaks Study, and Regional Board monitoring.

Monitoring conducted subsequent to the 1998 303(d) listing, including POTW monitoring, the CCCS and the Thousand Oaks Study, confirmed the basis for most of the listings. Monitoring data from the CCCS and Thousand Oaks Study indicate that oxidized nitrogen objectives are not being exceeded in reaches upstream of the Hill Canyon WTF or the Simi Valley WQCF. Oxidized nitrogen objectives are currently not exceeded in reaches downstream of POTWs unless the POTW nitrifies its effluent. Oxidized nitrogen objectives were exceeded in Revolon Slough, other agricultural areas, and Mugu Lagoon.

2.1.2.3 Algae and Dissolved Oxygen

Algae is identified on the 1998 303(d) list as a pollutant/stressor in Revolon Slough, Beardsley Channel, and each of the four reaches of Conejo Creek. For each location, it is listed as a low priority. Low dissolved oxygen is identified on the 1998 303(d) list as a pollutant/stressor in each of the four reaches of Conejo Creek.

An Aesthetic Stressor Worksheet was developed by the Regional board to summarize the visual observations made during 1991-1995 and used as the basic for the 303(d) listings (RWQCB, 1996b). Based on the number of observations and the number of criteria exceeded, a reach was then identified as "full supporting (F)", partially support (P)", or "not supporting (N)" beneficial uses.

Revolon Slough, Conejo Creek Reach 1, and Arroyo Simi Reach 1 were listed as "not supporting" beneficial uses. Beardsley Channel and Calleguas Creek Reach 3 were listed as "partially supporting" beneficial uses. The remaining reaches were considered fully supporting or included no observations. In the *1996 Draft Water Quality Assessment Data Summaries* documentation, the algae is described as contributing to a finding of:

- Not supporting both contact and non- contact recreation for Revolon Slough
- Not supporting both contact and non- contact recreation for the four Conejo Creek reaches (as a single category)
- Partially supporting both contact and non-contact recreation for Beardsley Channel

Table 6 summarizes the 1998 303(d) listings in the Calleguas Creek Watershed for the reaches impaired by algae and includes the related listings of nitrogen compounds and low dissolved oxygen in those reaches.

TABLE 6 SUMMARY OF 1998 303(D) LISTINGS

Reach	Aesthetic Stressor Summary 1991-1995	1996 Draft Water Quality Assessment Data Summary	1996 Draft 303(d) List[2]	1998 303(d) List[2]
Arroyo Las Posas Reach 1	No observations	No	No	No
Arroyo Las Posas Reach 2	F 0/1			No
Arroyo Simi Reach 1	N ¾	Algae: N for REC-1 and REC-2	No	No
Arroyo Simi Reach 2	F 1/1	No	No listings	No
Beardsley Channel	P 2/3	Algae: P for REC-1 and REC-2	Algae for REC-1 and REC-2	Yes
Revolon Slough	N 5/13	Algae: N for REC-1 and REC-2		Yes
Calleguas Creek Reach 1	No observations	No	No	No
Calleguas Creek Reach 2	No observations			No
Calleguas Creek Reach 3	P 2/5	No		No
Conejo Creek/ Arroyo Conejo North Fork	F ½	No	No	No
Arroyo Santa Rosa Reach 1 and 2	No observations[1]	Unassessed	No listings	No listings
Conejo Creek Reach 1	N 5/5	Algae: N for REC-1 and REC-2	Algae for REC-1 and REC-2	Yes
Conejo Creek Reach 2	F 1/3			Yes
Conejo Creek Reach 3	F 0/2			Yes
Conejo Creek Reach 4	F 0/2[1]			Yes
Arroyo Conejo South Branch	No observations	Unassessed	No listings	No listings
Mugu Lagoon	No observations	No	No	No

F = Fully supporting beneficial uses
P = Partially supporting beneficial uses
N = Not supporting beneficial uses
#/# = exceedances/total number of observations

1 Observations summarized as Conejo Creek Reach 4 are believed to be Arroyo Santa Rosa data because no data were found in the log sheets for Conejo Creek Reach 4 and field logs were found for Arroyo Santa Rosa.

2 Reaches listed as "No" were not listed on the 303(d) list for algae, but the reach is listed for other constituents. "No listings" indicates that there were no 303(d) listings at all for the reach.

The data do not provide algae observations or dissolved oxygen measurements of Mugu Lagoon. However, due to the high concentrations of nutrients in Revolon Slough, nutrient effects in Mugu Lagoon are potentially of concern. In addition, recent staff observations indicate the presence of algae along the shores of Mugu Lagoon. Consequently, investigation of potential algae and dissolved oxygen concerns in the lagoon is recommended and is included in the implementation plan.

2.1.3 TMDL Data

The data used to develop this TMDL were collected under different programs including Regional Board monitoring programs, the Calleguas Creek Characterization study, NPDES monitoring data, Department of Water Resources gauging, Ventura County Flood Control Division flow and stormwater data, US Geological Survey dry weather monitoring, Thousand Oaks Characterization Study, Arroyo Simi Characterization Study, and the 205(j) Non-point source study.

The POTWs monitor receiving water and effluent on a monthly basis, including ammonia, nitrate, and nitrite. Since 1986, the City of Thousand Oaks has conducted quarterly sampling at ten stations along the Conejo and Calleguas Creeks. From 1991 to 1996, the Regional Board conducted watershed monitoring at 24 stations. Finally, in 1998 and 1999, an integrated watershed water quality monitoring program (Calleguas Creek Characterization Study) collected monthly samples at 12 receiving water and eight discharge locations in the watershed. An associated monitoring program was instituted under a 205(j) non-point source grant to attempt to quantify non-point source loads in the watershed. Table 7 summarizes the data collection programs, the dates of sample collection, and number of stations.

TABLE 7 WATER QUALITY DATA SOURCES FOR CALLEGUAS CREEK

Data Source	Dates	Number of Discharge Stations[1]	Number of Receiving Water Stations
Calleguas Creek Characterization Study	7/98-6/99 (monthly)	8	12
205(j) Non-point sources Study (supplement to CCCS)	11/5/98, 5/5/99 dry, 2 wet 1/99	12	0
Ventura County Flood Control District (VCFCD) Stormwater data	1994-1999	8	2
POTW NPDES monitoring data	varies, 1991-present	5	9
Regional Board monitoring	1986-1995	4	20
Department of Water Resources	1952-1978	10	24
VCFCD and USGS dry weather monitoring	1975-1994	10	21

Thousand Oaks Characterization Study	1986-present	2	10
Arroyo Simi Characterization Study	1993-1994	1	7

1 Discharge includes tributaries to the main stem of the creek for this analysis.

Table 8 summarizes the types of data from each study and how they were used to develop the TMDL. Detailed data analysis is provided in the attendant technical report.

TABLE 8 USE OF CALLEGUAS CREEK WATER QUALITY DATA

Data Source	Use of Data
Calleguas Creek Characterization Study	Receiving Water data: Comparison to model results Calculation of current receiving water concentrations Discharge data: Calculation of POTW discharge concentrations and flows Calculation of Agricultural discharge concentrations
POTW NPDES Monitoring data	Calculation of current receiving water concentrations Calculation of POTW discharge flows
Regional Board Monitoring data	Calculation of current receiving water concentrations pH, temperature, and ionic receiving water concentrations
Department of Water Resources	Calculation of current receiving water concentrations pH, temperature, and ionic receiving water concentrations
VCFCD and USGS dry weather monitoring	Calculation of current receiving water concentrations pH, temperature, and ionic receiving water concentrations
Thousand Oaks Characterization Study	Calculation of current receiving water concentrations pH, temperature, and ionic receiving water concentrations
Arroyo Simi Characterization Study	Calculation of current receiving water concentrations pH, temperature, and ionic receiving water concentrations
205(j) Non-point sources study	Calculation of dry and wet weather urban runoff, agricultural, and open space concentrations
VCFCD Stormwater data	Calculation of wet weather urban runoff, agricultural, and open space concentrations

In each of the TMDL sections, data from these programs are summarized or referenced, where relevant. Data collected prior to 1980 were not used in the analysis, because they are not considered to be representative of current conditions.

In summary, the data reviewed as part of this TMDL confirms the 1998 303(d) listings. Water quality concentrations in the vicinity of several of the POTWs exceed the chronic water quality criteria for ammonia and to a lesser extent the acute water quality criteria. Toxicity tests also indicate both acute and chronic toxicity that appears to be related to ammonia. There are exceedances of the nitrate and nitrite standards in the ambient waters of Calleguas Creek. There appears to be more frequent exceedances of oxidized nitrogen objectives in the agricultural drains and in the lower reaches than in the upper reaches of the watershed. Additional monitoring surveys will be required to evaluate the extent and magnitude of the algae impairments in the watershed.

2.2 DEVELOPMENT OF NUMERIC TARGETS

The numeric targets developed by the Regional Board in this TMDL reflect the Regional Board's determination of the total pollutant loading capacity of the water body for the nitrogen compounds, accounting for seasonal variations, future growth and a margin of safety. Numeric targets for ammonia and oxidized nitrogen are based on the water quality standards described above. For this TMDL, the ammonia targets are based on the criteria developed by U.S. EPA, in the "1999 Update of Ambient Water Quality Criteria for Ammonia," December 1999 and adopted by the Regional Board in 2002. The 1999 Update contains EPA's most recent freshwater aquatic life criteria for ammonia and supersedes all previous freshwater aquatic life criteria for ammonia. In this revision the acute criteria is dependent on pH and the chronic criteria is based on pH and temperature. A 95^{th} percentile pH value was calculated from all of the pH data. Use of this percentile is consistent with State Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SWRCB, 2000a). The chronic criteria were calculated based on the average pH and temperature for the reaches using data for which both pH and temperature were available.

The 1999 USEPA Ambient Water Quality for Ammonia acknowledges that ammonia toxicity may be dependent on the ionic composition of the waterbody. For metals, these effects can be addressed by water effects ratio (WER) or other site-specific approaches, approved through the *Basin Plan* amendment process. The *Basin Plan* outlines the requirements for development of a Site Specific Objective (SSO). At this time, stakeholders and dischargers have under taken a WER study for ammonia. It is anticipated that WER study well serves as the basis for development of a proposed SSO for Regional Board approval.

The oxidized nitrogen targets are based on Water Quality Objectives for Selected Constituents in Inland Surface Waters as provided in the *Basin Plan* (Table 3-8) and the narrative objective for biostimulatory substances. The target based on the *Basin Plan* is 10 mg/L for Nitrate-nitrogen + nitrite-nitrogen in reaches above Potrero Road. For reaches below Potrero Road, the *Basin Plan* indicates that protection of the most sensitive beneficial use(s) would be the determining criteria for the selection of effluent limits (Basin Plan Table 3-8, footnote f). The most sensitive beneficial use for these reaches is groundwater recharge (GWR). The *Basin Plan* states that effluent limits for nitrogen are based on the appropriate groundwater basin objective. The *Basin Plan* provides a groundwater objective for nitrogen which is 10 mg/L nitrogen as nitrate-nitrogen plus nitrate-nitrogen, 45 mg/L as nitrate, 10 mg/L as nitrate-nitrogen, or 1 mg/L as nitrite-nitrogen which provide the target for reaches below Portrero Road. It is noted that Calleguas Creek, Revolon Slough and Mugu Lagoon are listed for nitrogen and algae.

The narrative objective for biostimulatory substances provided in the *Basin Plan* states:

> *"Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses."*

This TMDL establishes additional studies to determine if the nitrogen compound targets are sufficient to eliminate the related effects impairments, such as algae, in Calleguas Creek. If the proposed targets do not eliminate related effect impairments, the additional studies will provide data to support development of a site-specific objective for nitrogen in Calleguas Creek for consideration by the Regional Board. Table 9 summarizes the numeric targets for the Calleguas Creek Nutrient TMDL.

TABLE 9 SUMMARY OF NUMERIC TARGETS – CALLEGUAS CREEK NITROGEN TMDL

Parameter	Primary Use Protected	Numeric Targets (mg/l) Acute	Chronic
Ammonia –N			
Mugu Lagoon	WILD	4.7	2.3
Calleguas Creek, South	WILD, WARM	4.7	2.0
Calleguas Creek, North	WILD, WARM	3.9	2.2
Revlon Slough	WILD, WARM	5.7	2.1
Beardsley Channel	WILD, WARM	5.7	2.1
Arroyo Las Posas	WILD, WARM	10.1	2.5
Arroyo Simi	WILD, WARM	4.7	1.5
Tapo Canyon	WILD, WARM	4.7	1.5
Conejo Creek	WILD, WARM	8.4	3.1
Conejo Creek	WILD, WARM	6.9	3.1
Conejo Creek, Hill Canyon Reach	WILD, WARM	6.9	3.1
Conejo Creek, North Fork	WILD, WARM	3.2	1.5
Arroyo Conejo (South Fork Conejo Ck	WILD, WARM	10.1	2.9
Arroyo Santa Rosa	WILD, WARM	6.9	2.3
Nitrate-N	Basin Plan GWR	10	
Nitrite-N	Basin Plan GWR	1	
Nitrate + Nitrite	Basin Plan GWR	10	
pH	WILD, WARM	6.5 to 8.5	
Dissolved Oxygen	WILD, WARM	7 mg/l average; not less than 5 mg/l	

The *Basin Plan* narrative objective suggests that algal biomass is excessive when it impacts beneficial uses. One mechanism by which excess algal biomass can adversely impact beneficial uses is through eutrophication that results in low dissolved oxygen concentrations. Excess algal biomass can also affect recreational uses when it results in unpleasant odors and scum.

The *Basin Plan* provides a water quality objective for dissolved oxygen that can be used as a surrogate measure for the effects of eutrophication. There are no such targets for scum and odors which make it difficult to develop a target for algal biomass to reduce scum and odors.

2.3 SOURCE ASSESSMENT

This section summarizes the mass load estimates of nitrogen compounds to Calleguas Creek from point, nonpoint, and natural sources. This summary is based on the mass load analysis presented in the Technical Support Document.

Point sources to Calleguas Creek include discharges from wastewater treatment works, groundwater remediation projects, and industrial plants and are regulated through a National Pollution Discharge Elimination System (NPDES) permit or Waste Discharge Requirements (WDRs). Nonpoint sources to Calleguas Creek include stormwater and dry weather runoff from urban, agricultural, and open areas. Because urban and stormwater runoff are regulated through the Ventura County Municipal Stormwater NPDES permit, they are addressed as point sources in this document.

Agricultural drainage and runoff are addressed as a non-point source, although it can be conveyed to Calleguas Creek in ditches or pipes. Natural sources include loads from and atmospheric deposition of ammonia and oxidized nitrogen compounds and groundwater that is both naturally discharged and pumped from shallow aquifers. The ammonia and oxidized nitrogen load estimates, coupled with the maximum loads to meet water quality objectives, provides the basis for developing the Implementation Plan in this TMDL. Because the watershed contains different types of sources, the summary below discusses the load analysis both in the Calleguas Creek mainstem and Revolon Slough/Beardsley wash.

2.3.1 Point Sources

Point sources of nutrients to Calleguas Creek include:

- POTWs;
- groundwater from dewatering operations, remediation sites, well development and construction sites;
- stormwater runoff from industrial sources including manufacturing facilities, aggregate mines,

transportation facilities, wastewater treatment facilities and recycling facilities;

- stormwater runoff from urban and commercial sources; and
- stormwater runoff associated with construction activities.

The largest point sources of ammonia and oxidized nitrogen to Calleguas Creek are POTWs. Six POTWs, classified as major dischargers (i.e. annual average flow greater than 0.5 million gallons per day), discharge wastewater containing ammonia and oxidized nitrogen to Calleguas Creek. For all reaches except Revolon Slough, Beardsley Wash, and the upper watershed tributaries, the POTWs provide more than 85% of the flow to the Calleguas Creek watershed during dry weather.

The Camarillo Sanitary District Wastewater Treatment Plant (WTP), Hill Canyon Wastewater Treatment Facility (WTF), and City of Simi Valley Water Quality Control Facility (WQCF) discharge continuously to Conejo Creek, Arroyo Conejo, and Arroyo Simi, respectively. The Camrosa Wastewater Reclamation Facility (WRF) and Ventura County Wastewater Reclamation Plant (Moorpark WRP) reclaim most of their effluent for agriculture or groundwater recharge. The Camrosa WRF and Moorpark WRP discharge wastewater to Calleguas Creek during wet weather, if necessary. The Olsen Road Treatment Plant discharges to the Arroyo Santa Rosa, but will be taken out of service in the near future. Wastewater currently treated by the Olsen Road Treatment Plant will be diverted to the Hill Canyon WTF in early 2002.

Table 10 summarizes the POTWs in the watershed, along with their design capacities, receiving waters, and populations served.

TABLE 10 PUBLICLY OWNED TREATMENT WORKS IN THE CALLEGUAS CREEK WATERSHED

POTW	Current Design Capacity (cfs)	Receiving water	Population Served [1]
Hill Canyon Wastewater Treatment Facility	16.7	North Fork Arroyo Conejo	100,000
Simi Valley Water Quality Control Facility	19.3	Arroyo Simi	101,830
Camarillo Sanitary District Wastewater Treatment Plant	10.4	Conejo Creek	40,600
Moorpark Wastewater Treatment Plant	4.6	Arroyo Las Posas	26,932
Camrosa Wastewater Reclamation Facility	2.3	Calleguas Creek during wet season	24,000[2]
Olsen Road Water Reclamation Plant	1.2	Arroyo Santa Rosa	7500

1 Estimated population served from Bookman Edmonston, 1997.
2 Information from Camrosa website (www.camrosa.com).

Minor point sources in the Calleguas Creek Watershed discharge less than 0.1 million gallons per day. In addition, groundwater from shallow aquifers is discharged to Calleguas Creek. At least three minor dischargers of treated groundwater which is extracted from shallow aquifers to remediate contaminated sites in the Calleguas Creek watershed. Details on their location discharge type, and receiving water is provided in Appendix 2 of the Technical Support Document. Regional Board staff assumed that these sources are minor. The implementation plan includes the task to verify this assumption and to determent waste load allocation are required.

The load estimates are based on the product of the concentration of ammonia and oxidized nitrogen and the POTW effluent flow rate. Median concentrations and average effluent flow data from POTW monitoring programs in recent years were used to estimate the load of ammonia and nitrogen. The use of median concentration accounts for the effect of data fluctuations from the POTWs that only nitrify their effluent.

Ammonia and oxidized nitrogen loading can stem from organic nitrogen discharged in POTW effluent. As described in the Technical Support Document, the contribution of organic nitrogen to the total nitrogen load (ammonia and oxidized nitrogen) appears to be insignificant. This assumption will be confirm by monitoring during the implementation of this TMDL.

2.3.1.1 Ammonia

Table 11 summarizes the ammonia loads from the POTWs to Calleguas Creek and its tributaries. Load estimates are based on the CCCs from July 1998 through June 1999 and the average discharge flow rate as reported in POTW effluent monitoring reports for the same period.

TABLE 11 AMMONIA LOADS FROM POTW EFFLUENT

POTW	Median[1] Total Ammonia-N (mg/L)	Average Flow (cfs)	Average Load (lb/day)
Hill Canyon WWTP[2]	4.9	14	370
Simi Valley WQCF	24.7	14	1870
Camarillo WRP	2.2	3.2	34
Moorpark WWTP[3]	27.6	2	300
Olsen Rd. WRP	3.4	0.3	4.3
Total Ammonia Load			2,577.3

2.3.1.2 Oxidized Nitrogen

Table 12 summarizes oxidized nitrogen load from the POTWs into Calleguas Creek and its tributaries. Load estimates are based on the product of the average nitrite and nitrate concentrations reported in the CCCs from July 1998 through June 1999 and the average discharge flow rate was calculated from the POTW effluent monitoring reports for the same period.

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[1] Median concentrations are also used to estimate the load reductions. If the load reductions are based on the average of the data collected, the estimated load reduction would be different

[2] Hill Canyon concentration based on data reported in the1999 annual report after nitrification was implemented.

[3] Average flow for Moorpark when discharging to the Arroyo Las Posas.

TABLE 12 OXIDIZED NITROGEN LOADS FROM POTW EFFLUENT

POTW	Average Flow (cfs)	Median[1] Total Nitrate-N (mg/L)	Median[1] Total Nitrite-N (mg/L)	Average Nitrate-N Load (lb/day)	Average Nitrite-N Load (lb/day)
Hill Canyon WWTP[2]	14	7.8	0.96	589	73
Simi Valley WQCF	14	1.68	0.39	127	22
Camarillo WRP	3.2	28.5	0.18	493	3.1
Moorpark WWTP	2	0.18	0.045	1.9	0.5
Olsen Rd. WRP	0.3	2.5	0.045	1.7	0.08
Total				1,213	98.6

Additional oxidized nitrogen load is added from conversion of ammonia to oxidized nitrogen in the waterbody by natural processes. The nitrate load from ammonia conversion is dependent on the ammonia load from the POTWs as well as conditions such as temperature and pH within Calleguas Creek.

2.3.2 Nonpoint Sources

The major nonpoint source of nutrients to Calleguas Creek watershed are agricultural drainage and stormwater and urban surface runoff. Nutrient loads from groundwater that surfaces to Calleguas Creek were also evaluated and assessed to be a minor nonpoint source. This evaluation will be verified through a special study during the implementation of this TMDL.

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[1] Median concentrations are also used to estimate the load reductions. If the load reductions are based on the average of the data collected, the estimated load reduction would be different

[2] Hill Canyon concentration determined from the values reported in their 1999 annual report after nitrification was implemented.

2.3.2.1 Ammonia

Non-point ammonia loads were assessed according to land use types and runoff coefficients for ammonia concentrations in runoff during dry weather according to the land use types. The parameters and assumptions used to develop the ammonia loading estimates are summarized in the Technical Support Document. Table 13 summarizes the estimated ammonia loads from nonpoint sources to the watershed.

Based on the relatively low flow rates and low concentrations of ammonia from nonpoint sources, the ammonia load from nonpoint sources is insignificant relative to the ammonia loads from POTWs.

TABLE 13 AMMONIA LOADS FROM SURFACE RUNOFF

Reach	Arroyo Simi Upper	Arroyo Simi/Las Posas	Dry Calleguas	Arroyo Conejo Upper	Arroyo Conejo Lower	Arroyo Santa Rosa	Conejo Creek Upper	Conejo Creek Lower	Calleguas Creek Upper	Calleguas Creek Lower	Revolon Slough	Mugu Lagoon	Watershed
Urban Dry Weather													
Median Total Ammonia-N Concentration (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Estimated Flow (cfs)	1.7	1.3	0	1.8	0.92	0.31	0.35	0.077	0.010	0.025	1.4	0.39	
Estimated Load (lb/day) [1]	0.90	0.68	0	0.97	0.49	0.16	0.19	0.042	0.0054	0.013	0.75	0.21	4.4
Agriculture Dry Weather													
Median Total Ammonia-N Concentration (mg/L)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	
Estimated Flow (cfs)	0.0080	2.8	0	0	0.39	0.29	0.39	0.14	0.15	0.47	4.9	0.25	
Estimated Load (lb/day)	0.010	3.7	0	0	0.51	0.37	0.51	0.18	0.19	0.61	6.4	0.32	12.8
Open Space Dry Weather													
Median Total Ammonia-N Concentration (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Estimated Flow (cfs)	2.3	2.5	0	0.84	0.38	0.31	0.30	0.16	0.17	0.19	0.44	0.23	

Estimated Load (lb/day) [1]	1.2	1.3	0	0.46	0.21	0.17	0.16	0.088	0.091	0.10	0.24	0.12	4.1
Total Ammonia Load (lb/day)													21.3

1 Loads estimated assuming median concentration equals half the detection limit.

2.3.2.2 Oxidized Nitrogen

Non-point sources of flows were estimated based on flow information from Revelon Slough, Arroyo Conejo upstream of Hill Canyon, and Arroyo Simi upstream of the SVWQCP. Because no POTWs currently discharge to any of these areas, it can be assumed that all the water comes from the combination of agricultural runoff, urban runoff, open space runoff, and groundwater seepage. Concentrations in runoff from each source and estimated flows were used to approximate oxidized nitrogen loads from non-point sources in the Calleguas Creek Watershed. The parameters and assumptions used to develop the ammonia loading estimates are summarized in the Technical Support Document. Table 14 summarizes the estimated ammonia loads from nonpoint sources to the watershed.

TABLE 14 OXIDIZED NITROGEN LOADS FROM SURFACE RUNOFF

Reach	Arroyo Simi Upper	Arroyo Simi/Las Posas	Dry Calleguas	Arroyo Conejo Upper	Arroyo Conejo Lower	Arroyo Santa Rosa	Conejo Creek Upper	Conejo Creek Lower	Calleguas Creek Upper	Calleguas Creek Lower	Revolon Slough	Mugu Lagoon	Watershed
Urban Dry Weather													
Median N+N Concentration (mg/L)	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Estimated Flow (cfs)	1.7	1.3	0	1.8	0.92	0.31	0.35	0.077	0.010	0.025	1.4	0.39	
Estimated Load (lb/day) [1]	3.5	2.6	0	3.8	1.9	0.64	0.73	0.16	0.021	0.052	2.9	0.81	17.1
Agriculture Dry Weather													
Median N+N Concentration (mg/L)	32	32	32	32	32	32	32	32	32	32	32	32	
Estimated Flow (cfs)	0.008	2.8	0	0	0.39	0.29	0.39	0.14	0.15	0.47	4.9	0.25	
Estimated Load (lb/day)	1.4	500	0	0	69	51	69	24	26	83	870	43	1736
Open Space Dry Weather													

Median N+N Concentration (mg/L)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	
Estimated Flow (cfs)	2.3	2.5	0	0.84	0.38	0.31	0.30	0.16	0.17	0.19	0.44	0.23	
Estimated Load (lb/day) [1]	4.0	4.4	0	1.5	0.67	0.54	0.52	0.29	0.29	0.32	0.76	0.40	13.7
Total Nitrate + Nitrite Load													1766.8

1 Loads estimated assuming median concentration equals half the detection limit.

As shown in Table 14, the loading from agriculture represents the most significant nonpoint source of oxidized nitrogen loading in the watershed. As described in the Technical Support Document, the load estimate for agriculture in the Revolon Slough may be as much as 70% underestimated. These results indicate that agricultural discharges can contain significant nitrate concentrations. Additional investigation and monitoring are required to more accurately quantify agricultural loads.

Agricultural loading may also extend during wet weather when storm runoff from fields and orchards is present. Additional investigations and monitoring are included in the implementation plan to (1) more accurately quantify agricultural loads and the effectiveness of existing BMPs applied on a voluntary basis and their effects, (2) to predict the total nitrogen load reduction due to modifications of agricultural practice, and (3) to ensure that wet weather flows associated with high sediment transport to Mugu Lagoon do not constitute an additional critical condition.

2.3.2.3 Groundwater

The relative load of oxidized nitrogen contributed from groundwater flow to surface water appears to be significant in Simi Valley and Santa Rosa Valley. Groundwater data show the nitrate concentrations in these areas approach the numeric target of 10 mg/L. The surface water data show the in-stream nitrate concentrations exceed the numeric target between Highway 118 and the Moorpark treatment plant and between the downstream end of the Santa Rosa Valley and the Camarillo treatment plant. The implementation plan addresses this source with special studies to assess if groundwater discharge is responsible for the elevation of the surface water concentrations. The recommended studies should also quantify the contributions of septic, winter urban-runoff, agriculture, and waste treatment discharge sources. For additional discussion refer to the Technical Support Document.

2.3.2.4 Sediment

Oxidized nitrogen species may be entrained in sediment and later released to the surface water during transport. Where sediment deposition rates are high, such as Mugu Lagoon, or where rapid reductions in stream flow occur, such as Arroyo Las Posas, elevated oxidized nitrogen concentrations may be related to this phenomenon. In addition, the transport of nitrate may occur in sediment in addition to in solution.

While the total nutrient mass loading may not be significant in the upper watershed, additional studies identifying the sources of groundwater loading and the volume of groundwater discharge may clarify the nutrient load associated with sediment transport and deposition. Specifically, groundwater studies are proposed where a correlation is seen between elevated nitrate levels and flow loss in Arroyo Las Posas and below the Santa Rosa Valley.

The implementation plan addresses this source with further studies to assess nitrogen impairment for Mugu Lagoon. For additional discussion see Technical Support Document.

2.3.3 Natural Sources

Natural sources of ammonia and nitrogen loading to Calleguas Creek include atmospheric deposition. Limited data indicate that the magnitude of this nutrient source is insignificant relative to the magnitude of point and nonpoint sources of nutrients to Calleguas Creek.

2.3.4 Conversion of Other Nitrogen Compounds

Another potential source of ammonia is conversion of organic nitrogen to ammonia. Concentrations of organic nitrogen in the water body can be converted to ammonia. The amount contributed from this source will vary over time depending on the conditions in the water body and the amount of organic nitrogen in the water body. The amount of ammonia coming from the nitrogen conversion was estimated by using the conversion rate of 1 per day assumed in the model. Organic nitrogen concentrations from the CCCS and Regional Board monitoring data in reach were multiplied by the conversion rate and the travel time for the reach to estimate loads from this source. Conversion of organic nitrogen results in more ammonia loading to the water body than non-point sources of ammonia, but it is relatively insignificant compared to POTW discharges of ammonia.

2.3.5 Load Seasonality

An analysis of the load seasonality is provided in the Technical Support Document. It shows that the bulk of the ammonia and oxidized nitrogen load to Calleguas Creek is discharged during dry weather, however, nearly 30% of the annual ammonia load is discharged during wet weather events. The Technical Support Document provides an analysis showing that the increased loads due to storm flows will still meet numeric targets due to the increased assimilative capacity.

2.3.6 Summary of Sources

In summary, the major contributors of oxidized nitrogen loading to Calleguas Creek are POTWs and agriculture. Other possible sources will be quantified through additional studies described in the implementation plan.

2.4 LINKAGE ANALYSIS

This section describes the quantitative model developed to link ammonia and oxidized nitrogen sources to water quality impacts in Calleguas Creek. The model is a one dimensional, steady state, mass balance based model executed in Excel spreadsheets. The model accounts for point and nonpoint sources during dry weather conditions when effluent discharges from POTWs and agricultural drainage provide most of the stream flow.

The model consists of a series of eighteen elements, each of which corresponds to the location of a receiving water sampling site of the CCCS. For the purpose of the model, a base flow was established to account for flows from POTWs, agricultural drainage, storm drains, groundwater discharge, and other unknown sources. The elements are arranged in the following configuration to represent Calleguas Creek and its tributaries:

- Arroyo Simi and Arroyo Las Posas are represented by six elements in series;
- Arroyo Santa Rosa is represented by two elements in series;
- Arroyo Conejo is represented by three elements in series; The Arroyo Santa Rosa elements and Arroyo Conejo elements are parallel to each other and join together to form the Conejo Creek elements;
- Conejo Creek is represented by two elements in series;
- The Conejo Creek elements and Arroyo Las Posas elements are parallel to each other and join to form the Calleguas Creek elements;
- Calleguas Creek is represented by two elements in series;
- Revolon Slough is represented by one element that joins the Calleguas Creek between the Calleguas Creek elements;
- Other agricultural drains in the Oxnard Plain are represented by one element which joins Calleguas Creek after its second element to form an element representing Mugu Lagoon; and
- Mugu Lagoon is represented by a single element.

Each model element is represented by two inputs and two outputs. The first input to each element includes point, nonpoint and conversion sources. The second input to each element includes loads from the upstream element which flow into the element under analysis. The first output from each element includes losses to groundwater and evaporation. The second output from each element is the load flowing from the element under analysis to the downstream node. Mass is balanced by calculating the concentration in the outflow stream so there is no net mass accumulation in each element. The concentration in the outflow stream represents the instream concentrations. The technical support document provides the types of inputs and outputs from a mass balance load, and the assemblage of nodes used to characterize the Calleguas Creek watershed, respectively.

The mass balance model uses a cascade of stirred tanks approach, so discharge from an upstream reach to a downstream reach is computed using the equation:

$$Q\ out = Qin_1 + Qin_2 + \ldots + Qin_n - Qwithdrawals \qquad \text{...(Equation 3)}$$

The model assumes immediate and complete mixing of all inputs within each element. The model incorporates losses and gains of contaminant mass by conversion (oxidation) of individual constituents based on conversion values published in the technical literature. In-stream conditions for each reach are calculated using flow volume and contaminant concentration of inflows to the reach, using the equation:

$$C\ out = 1/Qout\ \ x\ (Cin_1Qin_1 + Cin_2Qin_2 + \ldots + Cin_nQin_n) \qquad \text{.............................(Equation 4)}$$

Loads for the following constituents were calculated: Ammonia, Nitrate, Nitrite, and Total Kjeldahl Nitrogen (TKN) The calculation method is based on mass continuity and involves balancing contaminant mass inputs and outputs from each element, except for the terminal element which represents Mugu Lagoon. Data used in developing the model include flow and water quality monitoring from the 205(j) monitoring program and the CCC. In addition, data regarding flow and chemical constituents from point sources and significant non-point sources were used to both estimate the loads and assess water quality impacts. The data were also used to calibrate the model. In addition to measured data, the model is based on assumptions for flow rates from nonpoint sources and conversions of other chemical forms. The basis for these assumptions is described below.

2.4.1 Flow Analysis and Data

Flow characterization is a key parameter in determining the assimilative capacity and TMDLs of Calleguas Creek. This section reviews the flow measurement data for Calleguas Creek and sets forth a critical condition for the nutrient TMDLs. This review is based on the analysis provided in the Technical Services Document.

A key consideration in linking sources and instream water quality for Calleguas Creek is the lack of connectivity between key reaches and tributaries during dry weather flow conditions. Some of the point sources are located on lower order tributaries that do not connect directly to the higher order tributaries. For example, under dry weather conditions, surface flow in Arroyo Las Posas is lost to groundwater recharge and does not reach Calleguas Creek. Because the major point sources are located on tributaries of Calleguas Creek, water quality impacts from both point and nonpoint sources need to be evaluated according to the assimilative capacity at different locations within the watershed.

Different types of flow measurements have been collected in the watershed, but only a few have been collected using reliable methods over a sufficient period of time for analysis. Table 15 summarizes the sources of flow information, a description of their location, and the data available.

Conejo Creek flows are characterized by VCFCD flow gauges located on Conejo Creek and lower Calleguas Creek and the TOCS measurements. In addition, flow meters, rather than visual estimates, were used to determine flow during the CCCS by monitoring agencies on portions of the Conejo Creek. Based on the measurements, flows on the Conejo Creek were considered to be accurately quantified.

TABLE 15 HYDROLOGIC DATA SOURCES FOR CALLEGUAS CREEK

Source of Flow Information	Location	Years of Record	Type of Measurement
Thousand Oaks Characterization Study	1 mile intervals on Conejo and Calleguas Creeks	Quarterly from 1986-present	Hand-held velocity meter
Arroyo Simi Characterization	4 stations on Arroyo Simi from Royal Rd. to Hitch Blvd.	Quarterly measurements 1993-1994.	Hand-held velocity meter
Calleguas Creek Characterization Study	15 stations throughout watershed	Monthly from 7/98-6/99	Estimates of width, depth, and velocity
VCFCD flow gauges			
803	Arroyo Simi at Madera Rd.	Daily from 1984-1999	Continuous monitoring permanent flow station
806	Calleguas Creek at Hwy 101	Daily from 1984-1999	Continuous monitoring permanent flow station
805	Conejo Creek at Santa Rosa Rd.	Daily from 1984-1999	Continuous monitoring permanent flow station
801	Calleguas Creek at Camarillo State Hospital	Daily from 1984-1999	Continuous monitoring permanent flow station
776	Revolon Slough at Laguna Rd.	Daily from 1984-1999	Continuous monitoring permanent flow station

The flow rate data on the Arroyo Simi/Las Posas do not allow a similar flow characterization. There are two VCFCD gauges on this reach of the creek system, 803 and 806. Gauge 803 is located upstream of the POTW discharges in the watershed. Gauge 806 is located on Calleguas Creek in the portion of the system that is dry except for high, wet season flows. The Arroyo Simi Characterization and the CCCS represent one year of flow measurements on the system, and the CCCS results are estimates, not recorded flows. Therefore, the flow analysis developed for the Conejo/Calleguas system was used to address the areas of the Arroyo Simi where flow data were not available (i.e. downstream of the Simi Valley WQCF), as described below.

2.4.2 Critical Conditions

The model simulates the dry weather, low flow critical condition in Calleguas Creek. For the

Calleguas Creek watershed, the critical condition is defined as a 30Q3[1] flow during dry weather months. This flow regime is marginally greater than the 7Q10[2] which is defined by EPA as a minimum flow regime. The model allows estimation of an implicit margin of safety associated with the loading under critical conditions.

A flow regime for Calleguas Creek was set forth to develop these TMDLs. Because POTWs' effluent comprises a major component of the flow, and the watershed is subject to droughts, a low flow condition such as the 7Q10 or 1Q10[3] flow yields flows that are close to zero in many of the Calleguas Creek reaches. For this reason, another, more appropriate flow regime was evaluated. Because ammonia and algae/dissolved oxygen effects are most deleterious during the summer months, dry weather flows were considered in the analysis. For many objectives, including ammonia, there is a requirement that the objective not be exceeded more than once every three years (USEPA, 1999c). Therefore, the lowest monthly dry weather average with a return period of three years was used as the baseline flow. Table 16 lists the baseline flows, based on current POTW discharges, for each reach in the Calleguas Creek Watershed.

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[1] 30Q3: average of the lowest flows occurring on 30 consecutive days during the dry season, with a return period of 3 years

[2] 7Q10: lowest average 7 consecutive day of low flow with an average recurrence frequency of once in 10 years determined hydrologically

[3] 1Q10: lowest one day flow with an average recurrence frequency of once in 10 years determined hydrologically

TABLE 16 SUMMARY OF HYDROLOGIC DATA FOR CALLEGUAS CREEK

Reach	Lowest 3-year Monthly Flow (cfs)
Arroyo Simi Upper	3.9
Arroyo Simi/Las Posas	18.0
Dry Calleguas	0
Arroyo Conejo Upper	4.0
Arroyo Conejo Lower	18.0
Arroyo Santa Rosa	1.0
Conejo Creek Upper	14.0
Conejo Creek Lower	12.0
Calleguas Creek Upper	11.0
Calleguas Creek Lower	12.0
Revolon Slough and Agriculture Drains	5.2
Mugu Lagoon	N/A

The 30Q3 is equal to the 15-20th percentile mean daily flow in the watershed. This mean that 80% of the time, the flow component of the margin of safety is greater than estimated and 20% of the time it is lower. To quantify the flow component of the margin of safety during the 20% of the time that the flows are lower than the baseline, a number of flows representing percentile below 20 were selected, and the margin of safety under these flow regimes was calculated. Table 17 summarizes these values.

Winter storm flows may constitute critical conditions for nutrient loading due to agricultural and urban runoff loading to surface or groundwater or nitrogen transport in sediment to Mugu Lagoon. Limited data suggests that any increased loading is offset by increased assimilative capacity in Calleguas Creek. The implementation plan includes additional studies to ensure that the dry season conditions for which this TMDL is written provide sufficient loading control.

TABLE 17 ESTIMATED MARGIN OF SAFETY UNDER DIFFERENT FLOW CONDITIONS

Percentile	Approximate Flow Represented by the Percentile Flow[1]	Estimated MOS[2]
0.1	1Q10	2%
1	1Q3 and 7Q10	12%
5	7Q3 (Revolon, Conejo)	15%
10	7Q3 (Arroyo Simi, Calleguas)	18%

2.4.3 Application of the Model

The model was used to verify the linkage between the sources and instream water quality for ammonia and oxidized nitrogen and to assess the effectiveness of various waste load and load allocations and load reduction strategies to meet numeric targets for ammonia and oxidized nitrogen. The model was also to estimate the effect of different load reduction strategies on algal biomass and dissolved oxygen and the process. The model was calibrated against the critical condition and monitoring data to verify its range of accuracy. The modeling procedure and scenarios are summarized in this subsection.

The modeling scenarios include dry weather and storm conditions, described below:

- Dry weather flow condition – this scenario was modeled at the representative flow conditions and source concentrations to calibrate the model and establish critical conditions;
- Storm flow condition – this scenario was modeled to show that storm flow did not increase

[1] The actual percentile for each flow varies by the reach. The percentile for the 7Q3 flow varies the most, from the 3rd percentile in Revolon to the 10th percentile in the arroyo Simi. As a result, both the 5th and the 10th percentile calculations were included for comparison.

[2] MOS estimated based on the associated percentile flows at VCFCD gage 803, upstream of Simi Valley QWCF. No other gages are available upstream of POTW discharges to allow for analysis.

nutrient loadings relative to the increase in stream flow, and thereby did not constitute critical conditions;

- Nitrification/Denitrification at Simi Valley, Camarillo, and Moorpark POTWs – this scenario was modeled to determine the effect of implementing nitrogen removal technologies at key POTWs to determine the effectiveness of these implementation scenarios on receiving water quality;
- Implementation of Agricultural BMPs - this scenario was modeled to determine the effectiveness of this Implementation scenario on receiving water quality;
- Treatment of agricultural discharge - this scenario was modeled to determine the effectiveness of this Implementation scenario on receiving water quality; and
- Effect of flow diversion - this scenario was modeled to determine the effect of the flow diversion on receiving water quality.

The key parameters of each model scenario are defined in the attached Technical Support Document. The model successfully links the sources to instream water quality. Key results from the model are:

- Scenario 1: The model predicts in stream impairments for ammonia and nitrate in locations where water quality data indicate exceedences of numeric targets. The dry weather scenario defines the critical flow condition for nutrients in the Calleguas Creek system;
- Scenario 2 – Storm Flow Condition: Storm runoff does not degrade water quality relative to the critical condition. Although nutrient loadings are increased, the greater increase in stream flow reduces the instream nutrient concentrations;
- Scenario 3: Implementation of Nitrification/denitirification wastewater treatment at Simi Valley, Camarillo, and Moorpark POTWs; this scenario will reduce nutrient loadings to Calleguas Creek and its tributaries to meet water quality objectives;
- Scenario 4: Effects of the proposed Conejo Creek Diversion: The planned diversion will degrade water quality and increase the instream concentrations of nutrients;
- Scenario 5: Agricultural BMPs; The model indicates that implementation of agricultural BMPs may not achieve numeric targets for nitrate. Due to lack of data on the extent to which BMPs are implemented in agriculture, there is great uncertainty in modeling this scenario. The Implementation Plan reflects this uncertainty and sets forth activities to evaluate the extent to which agricultural BMPs are used in the Calleguas Creek watershed; and

- Scenario 6: Treatment of Agricultural Discharge: This scenario indicates that treatment of agricultural discharge will achieve water quality objectives in Calleguas Creek.

Contaminant concentration results from modeling generally agreed with analytical results reported in Calleguas Creek Characterization Study within 20%.

2.5 ALLOCATIONS

This section develops waste load and load allocations for ammonia and oxidized nitrogen discharges to Calleguas Creek. The reduction in loading required to attain water quality targets is based on waste load allocations for ammonia and oxidized nitrogen from POTWs and implementing Best Management Practices for agriculture discharges.

2.5.1 Waste Load Allocations

This section sets forth waste load allocations (WLAs), which identify the portion of the loading capacity allocated to existing and future point sources (40 CFR 130.2(h)). The waste load allocations distribute the loading capacity among individual major point sources to meet water quality standards for nutrients. As discussed below, the waste load allocations include a 10% explicit margin of safety.

Waste loads are allocated to Simi Valley WQCF, Hill Canyon WWTF, Camarillo WRP, Moorpark WWTP, and Camrosa WRF. Discharges from these sources comprise approximately 85% of the ammonia and approximately 50% oxidized nitrogen loads to Calleguas Creek during critical conditions.

The waste load allocations for Simi Valley WQCF, Hill Canyon WWTF, Camarillo WRP, Moorpark WWTP and Camrosa WRF are based on the design capacity and effluent concentrations needed to meet instream water quality standards for ammonia. The limits for total ammonia are based on the chronic criteria for the reaches where the effluent is discharged.

The aggregate ammonia WLA for the POTWs is 697 lb. per day. The oxidized nitrogen (nitrite plus nitrate) WLA is 2,516 lb/day. Allocations for future growth are provided by basing the waste load allocations on the design capacity rather than the average effluent flow rates from the POTWs. Table 18 shows the Ammonia Effluent Limit and WLAs for the POTWs in the Calleguas Creek watershed.

TABLE 18 WASTE LOAD ALLOCATIONS FOR AMMONIA

POTW	Ammonia-N Daily Effluent Limit (mg/L)	Daily WLA (lb/day)
Hill Canyon WWTP	2.8	227
Simi Valley WQCF	1.35	127
Moorpark WWTP	2.8	42
Camarillo WRP	3.4	172
Camrosa WWTP	3.4	129
Olsen Rd. WRP [5]	N/A	N/A

These limits include an explicit margin of safety of 10%. Future growth is addressed by basing the WLA on the POTWs design capacity rather than average flow rate.

Table 19 shows the Effluent Limits for oxidized nitrogen and WLAs for the POTWs in the Calleguas Creek watershed.

TABLE 19 WASTE LOAD ALLOCATIONS FOR OXIDIZED NITROGEN

POTW	Nitrite-N Effluent Limit (mg/L)	Nitrate-N Effluent Limit (mg/L)	Nitrite-N WLA (lb/day)	Nitrate-N WLA (lb/day)	Nitrate-N+ Nitrite-N WLA (lb/day)
Hill Canyon WWTP	0.9	9	81	810	891
Simi Valley WQCF	0.9	9	94	938	1032
Moorpark WWTP	0.9	9	15	150	165
Camarillo WRP	0.9	9	51	506	557
Camrosa WWTP	0.9	9	11	112	123
Olsen Rd. WRP	N/A	N/A	N/A	N/A	N/A

Use of effluent limitations to set waste load allocations ensures equity among dischargers. The greatest mass reductions are expected from the Simi Valley WQCF plant which currently contributes about 80% of the total POTW nitrogen load to Calleguas Creek.

As described in Section 2, the numeric objective can potentially be modified through development of a SSO for ammonia. Modification of WLAs based on SSOs will require demonstration that any increased load does not cause or exacerbate impairments of other water quality objectives, such as objectives for oxidized nitrogen or nutrient effects such as algae or dissolved oxygen.

These waste load allocations will be sufficient to meet the water quality objectives for ammonia and oxidized nitrogen in Calleguas Creek and its tributaries, except for Revolon Slough and Beardsley Wash where there are no nutrient point sources. The assessment that the WLAs will achieve water quality objectives is based on two key assumptions: (1) there are no other point sources with sufficient flow or concentration to increase instream concentrations above the target; (2) there are no nutrient sinks, such as sediments, in the Calleguas Creek system that accumulate ammonia or oxidized nitrogen.

The first assumption will be verified by studies to be conducted as part of the implementation plan. Based on these studies, the Regional Board may develop waste load allocations for the minor NPDES dischargers. Monitoring requirements may be placed on minor NPDES dischargers to refine the estimates of nitrogen loadings and provide the baseline for specific WLAs in the future if necessary.

The Regional Board staff has concluded that the second assumption is reasonable because much of the Calleguas Creek system is channelized and sediments that may accumulate in these channels are likely to be flushed out to Mugu Lagoon during major storms.

2.5.2 Load Allocations

This section develops load allocations for agricultural discharges which is the major non-point source of oxidized nitrogen to Calleguas Creek and its tributaries. This source is particularly significant in Revolon Slough and other agricultural drains in the lower Calleguas watershed where there are no point sources of ammonia and oxidized nitrogen. Additional monitoring data are needed to refine the estimates of ammonia and oxidized nitrogen contributions from urban runoff. Load allocations for other non-point sources may be developed in the future if monitoring data indicates that loads are greater than assumed in this assessment and the prescribed waste load and load allocations do not result in attainment of water quality objectives. These load allocations may require BMPs to address dry weather runoff from urban areas, such as runoff of fertilizers from lawns. Table 20 shows load allocations for nitrate and nitrite.

TABLE 20 LOAD ALLOCATIONS FOR OXIDIZED NITROGEN

Nonpoint Source	Nitrate-N + Nitrite-N Effluent Limit (mg/L)	Daily LA (lb/day) [4]
Agriculture – Revolon Slough	9	230
Agriculture – Arroyo Las Posas	9	6

2.6 CRITICAL CONDITIONS AND SEASONALITY

The critical period for this TMDL is the warmer, dry-weather season when flow rates and the assimilative capacity in the Calleguas Creek system are low. Summer reflects the critical condition for ammonia since toxicity is greater at higher temperatures. In addition, the combination of warmer temperatures greater than sunlight, and stable low-flow conditions in the summer is also likely to create conditions conducive for algae growth.

During low flow periods, POTW effluent comprises most of the flow (typically 80%) and is the greatest source of the nitrogen loadings to Calleguas Creek and its tributaries, except Revolon Slough, Beardsley Wash, and the upstream tributaries. Consequently, there is minimal dilution during this critical period. As discussed above, wet weather events provide additional assimilative capacity and yield lower concentrations of ammonia and oxidized nitrogen than dry weather conditions. The critical low flow condition (30Q3) is comparable to the 7Q10 flows in the watershed that was used in this TMDL analysis.

2.7 MARGIN OF SAFETY

This TMDL includes a margin of safety to account for uncertainty concerning the relationships between WLAs and water quality. The margin of safety includes both implicit and explicit components. The implicit margin of safety is largely based on the following conservative estimates in setting up the critical conditions for the model:

- Use of low flow condition (30Q3) which provides minimal dilution (average of the lowest flows occurring on 30 consecutive days during the dry season, with a return period of 3 years). This equates to a 0.2 percentile flow. *(Note: A 30Q5[1] would reflect the lowest monthly average over a 5-year period or the 2nd percentile).*

- For ammonia loads allocations, a 90th percentile flow for setting the target for acute toxicity. Median values for pH and temperature were used in setting the target for the chronic criteria.

In addition to these conservative assumptions, an additional 10 percent reduction has been built into the WLAs for ammonia provided in Table 20. The effluent limit required to meet the acute criteria of 3.88 mg/L is reduced to 3.5 mg/L and the limit required to meet the chronic criteria of 1.71 mg/L is reduced to 1.5 mg/L.

A mass balance model was used to quantify the sources of nitrogen and to model the results of the TMDL remedy. Multi-dimensional dynamic modeling for the Los Angeles River and Malibu Creek nutrient TMDLs have resulted in different numeric targets, TMDL remedies, and load and waste load allocations than those which might have been derived based on earlier mass balance models in the same watersheds.

As a result, the explicit margin of safety is proposed for Calleguas Creek relative to discharges from groundwater, eutrophication effects in the lagoon where circulation is limited, and attached algae impairment, for which the more detailed models described provided a more extensive description. Specifically, if the additional studies identified in the Implementation Plan do not provide sufficient

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[1] 30Q5: lowest average 30 consecutive days low flow with an average recurrence frequency of once in 5 years determined hydrologically

detail on these issues, a greater margin of safety should be applied to the nitrate loading than that proposed in this TMDL. For additional discussion see Technical Support Document.

2.8 FUTURE GROWTH

The population in the Calleguas Creek watershed is expected to grow approximately 20% in the next ten years, based on the cities development plans. Population growth will impact Calleguas Creek in the form of additional nutrient loads in POTW effluent and potentially, greater non point source loads. The load will increase proportionally to the population increase if it is assumed that future domestic water use per person and future nutrient load per household are approximately equal to current water use and nutrient loads. Under those assumptions, the volume of wastewater discharged by the POTW is also projected to increase proportionately to the population increase.

Because impairments are based on instream nitrogen concentrations, increased loads from POTWs will not add to the impairment as long as they are contained in discharges with sufficient flow and as long as nitrogen compounds do not accumulate in the watershed. Therefore, the projected future increase in nitrogen loads from the POTWs in the watershed due to population growth is not expected to exacerbate the impairment. WLAs for POTWs are specified proportional to discharge volume, such that the nutrient concentration in the discharge will equal the concentration specified in WLAs effective in 2001.

Future growth is addressed in this TMDL by allocating waste loads based on design capacity of the existing POTWs in the watershed. The current nutrient loads are based on POTW effluent flow rates which are less than the design capacity. Future growth that would exceed POTW capacity will entail increasing POTW capacity or construction of new POTWs. Either scenario entails the construction of new treatment capacity which will require a modification to existing or new NPDES permits. Revision of WLAs can be incorporated into the NPDES permits, if appropriate.

3 SUMMARY OF TMDL

This TMDL sets Waste Load Allocations for ammonia, nitrate, nitrite, and nitrate+nitrite for POTWs discharging to Calleguas Creek and its tributaries. Effluent limits are designed to ensure compliance with the water quality standards for ammonia based on the updated ammonia criteria, and nitrate and nitrite based on the existing Basin Plan objective. Under this TMDL the ammonia loadings will be reduced from around 313,497 lbs/mo to around 40,786 lbs/mo. This represents an 87% reduction in the total ammonia loads. Table 21 compares the proposed WLAs to the current loading estimates.

TABLE 21 WASTE LOAD AND LOAD ALLOCATION SUMMARY BY SOURCE

	Loads (lb/day) (based on discharger effluent data for POTWs)		Proposed Waste load allocations (lb/day)		Reduction in current load due to WLAs, %	
Constituent	POTWs	Non-point source	POTWs	Non-point source	POTWs	Non-point source
Ammonia-N	2578	12.8	697	12.8	73%	0%
Nitrate+Nitrite-N	1312	1736	2768	236	-110%	86%
Total ammonia and oxidized nitrogen	3890	1749	3465	248	11%	86%
Total nitrogen reduction from POTWs and agriculture						34%

This TMDL implements mass limits for ammonia and oxidized nitrogen. The mass limits are designed to meet water quality objectives for ammonia, nitrate and nitrate. Their effect on nutrient effects will be evaluated to determine the effectiveness of the WLAs in meeting the water quality objectives for nutrient effects such as algae and dissolved oxygen. Additional WLAs or LAs may be developed or implemented at a future date should the monitoring data indicate non-attainment of water quality standards or other instream targets.

4 IMPLEMENTATION

This section describes the proposed implementation plan to meet water quality objectives for nitrogen and effects in Calleguas Creek. The Implementation Plan includes the following elements:

- wastewater treatment to remove ammonia and oxidized nitrogen from POTW effluent;
- implementation and evaluation of agricultural best management practices (BMPs) in the Calleguas Creek watershed;
- continued monitoring for nutrients and their effects in Calleguas Creek; and
- additional studies to address issues for which the data is insufficient to assess the nutrient problem and its resolution in Calleguas Creek, including algae and dissolved oxygen.

4.1 WASTEWATER TREATMENT

The WLAs for ammonia, nitrite, and nitrate established in this TMDL will be implemented as effluent limits in the NPDES permits for the POTWs discharging in the Calleguas Creek watershed. These effluent limits will be achieved by incorporating nitrification and denitrification operations, as needed, in the POTW wastewater treatment processes. Nitrification reduces the ammonia load by oxidizing it to nitrite and nitrate, and denitrification reduces the nitrite and nitrate loads by reducing these compounds to gaseous nitrogen. For the POTWs that do not currently denitrify their effluent, it is anticipated that denitrification will be required to meet oxidized nitrogen objectives. Presently, the Hill Canyon and Camrosa POTWs denitrify their effluent.

The regulatory framework for achieving the ammonia objective is established by the *Basin Plan*. The *Basin Plan* provides that the compliance date for the inland surface water ammonia objective is June 13, 2002. Specifically, the *Basin Plan* states that, "timing of compliance with this objective will be determined on a case-by-case basis. Discharges will have *<u>up to</u>* *8 years following the adoption of this plan by the Regional Board* to (i) make the necessary adjustments/improvements to meet these objectives or (ii) to conduct studies leading to an approved site-specific objective for ammonia. If there is an immediate threat or impairment of beneficial uses due to ammonia, the objectives in Tables 3-1 to 3-4 shall apply" (emphasis added) (Basin Plan, p. 3-3). For clarification, the latest allowable compliance date is, therefore, June 13, 2002.

On May 31, 2001 Regional Board staff presented a Status Report on Publicly Owned Treatment Works' (POTWs) Timely Progress toward Compliance with Inland Surface Water Ammonia Objectives to Protect Aquatic Life, as Stipulated in the *Basin Plan*. Staff reported that most of the POTWs in the Calleguas Creek watershed are already in compliance with the ammonia objective or expect to be in compliance by the June 13, 2002 deadline. Staff recommended that the Regional Board evaluate on a case-by-case basis the appropriateness of (1) issuing Time Schedule Orders for those POTWs that will not achieve compliance by the deadline and/or (2) finding the discharges in violation of permit conditions and taking other enforcement actions. Consequently, for the POTWs that cannot meet the ammonia target, the Board must consider appropriate enforcement actions and/or issue a time schedule order.

Compliance with oxidized nitrogen targets will involve both point source and non-point source controls. For POTWs, compliance with the oxidized nitrogen targets is related to compliance with the ammonia target, because the preferred method of meeting the ammonia target is to oxidize ammonia to nitrate (i.e. denitrify effluent). The nitrified effluent will need to be denitrified to meet oxidized nitrogen objectives. Because planning and implementation of denitrification facilities is estimated to require 4 years for planning, design, and construction, based on information in the Technical Support Document, for POTWs that cannot meet the oxidized nitrogen targets, interim discharge limits described in Section 4.1.1 will apply for a period of 4 years after the effective date of the TMDL.

4.1.1 Interim Nitrate Limits

Several of the POTWs in the Calleguas Creek watershed will require additional time to meet the oxidized nitrogen (nitrate, nitrite, and nitrate + nitrite) WLAs. As POTWs implement nitrification processes to comply with the ammonia objective, additional oxidized nitrogen will be generated in the POTW effluent. To allow time for completion of denitrification facilities which are integral to this TMDL, the amendment to the Basin Plan that includes this TMDL allows for higher interim limits listed in Table 22 for a period of four years from the effective date of the TMDL while the appropriate upgrades are effected to achieve full compliance.

The interim effluent limits are based on POTW performance as reported in the Technical Support Document and are based on a summation of ammonia, nitrite, and nitrate concentrations in POTW effluent. These interim limits will apply to nitrate, nitrite, and nitrate + nitrite only. The time period is also based on estimates in the Technical Support Document in which the planning tasks (planning, CEQA, finance, and design) are assumed to be conducted concurrently and take two years. The construction of capital improvements is assumed to follow the planning tasks and is also scheduled for two years. Table 22 provides the oxidized nitrogen interim limits. Interim nitrate limits for the Camrosa Water Reclamation Facility are not provided because the facility currently denitrifies its effluent and only discharges to Calleguas Creek during storm events.

TABLE 22 CURRENT EFFLUENT CONCENTRATION, TMDL TARGET, AND INTERIM NITRATE LIMIT

	Current effluent concentration from POTWs (mg/L)			TMDL Target (mg/L)			Interim Nitrate Limit
POTW	Median Total Ammonia-N	Median Total Nitrate-N	Median Total Nitrite	Ammonia-N	Nitrate-N	Nitrite-N	
Hill Canyon WWTP[1]	4.9	7.8	0.96	2.8	9	0.9	13.66
Simi Valley WQCF	24.7	1.68	0.39	1.35	9	0.9	26.77

[1] Hill Canyon concentration based on data reported in the1999 annual report after nitrification was implemented.

Camarillo WRP	2.2	28.5	0.18	3.4	9	0.9	30.88
Moorpark WWTP[1]	27.6	0.18	0.045	2.8	9	0.9	27.82
Olsen Rd. WRP	3.4	2.5	0.045	N/A	N/A	N/A	N/A

4.2 NON-POINT SOURCE CONTROL

Load allocations will be implemented in accordance with the State's *Nonpoint Source Management Plan* which describes a three-tiered approach to address nonpoint source loads, including: (1) voluntary implementation of Best Management Practices, (2) regulatory-based enforcement of BMPs, and (3) prescription of effluent limitations. The management plan generally prescribes the least stringent option that will restore and protect water quality.

This TMDL and Implementation Plan acknowledges that the status of implementation of non-point source BMPs throughout the Calleguas Creek watershed is not well documented. The Regional Board will organize a non-point source oversight committee. The committee will be comprised of Regional Board staff and interested Stakeholders including the Calleguas Creek Watershed Planning Committee and Ventura County Conservation District. The committee will initially focus on agriculture loads and BMPs because studies show that agriculture loads are the largest non-point source load. The committee's first meeting is scheduled on September 18, 2002 at the Venture County Farm Bureau. The committee will participate in the following activities with Regional Board Staff to: 1)quantify fertilizer application practices and loading rates to groundwater through leaching and surface waster through runoff, 2) describe BMPs to manage, 3)identify extent of BMPs usage, 4)outreach, education, fiscal support targeted by BMP and by prioritized areas, 5)BMP installation and oversight, 6)identification of non compliant users, and 7)issue WDRs or waivers with time schedules order as

[1] Average flow for Moorpark when discharging to the Arroyo Las Posas.

appropriate. This Implementation Plan includes an evaluation of non-point source BMPs to reduce nitrogen loadings to Calleguas Creek and develop a Pollution Prevention Plan based on the results of the evaluation. The Pollution Prevention Plan will assess the potential for implementing non-point source best management practices to reduce the current loadings to levels necessary to meet water quality objectives. The committee's Pollution Prevention Plan will be due to the Regional Board one year after the effective date of this TMDL . A non point source committee will be established to develop a Pollution Prevention Plan focussed on the reduction of nutrient sources from agricultural activities.

The Implementation Plan for the TMDL recognizes that different types of agriculture will require different loading reductions and BMPs to meet the load allocations for agriculture in the watershed. Evaluation of the effectiveness of the agricultural BMPs in reducing non-point source pollutants will be based on monitoring results, described below. If such results do not indicate that voluntary implementation of best management practices are effective, the Regional Board will evaluate subsequent, regulatory-based enforcement of Best Management Practices and adoption of WDRs.

4.3 MONITORING

Local stakeholders have formed a committee, termed the Calleguas Creek Watershed Planning Committee, to address water quality concerns in Calleguas Creek. The Calleguas Creek Watershed Planning Committee has agreed to develop a regional plan to address water quality issues, including development of the additional TMDLs required by the consent decree. The Calleguas Creek Watershed Planning Committee is responsible for the TMDL monitoring required by this TMDL and other TMDLs in the Calleguas Creek watershed, except for the existing POTW monitoring programs which will be continued to be conducted through the existing monitoring programs for NPDES compliance.

This TMDL includes development of a monitoring program to assess compliance with the targets identified in this TMDL, evaluate changes to algal biomass and the presence of scum and odors throughout the watershed and in Mugu Lagoon, refine source estimates from minor point source discharges and dry and wet-weather flows from non point sources. These data will be reviewed 3 years after the effective date of the TMDL to evaluate the effectiveness of this TMDL and to determine if revision of WLAs or additional LAs are required. The need for any TMDL revisions will be evaluated at the time of permit renewal.

The details of the monitoring plan include, but are not limited to: 1) a core compliance monitoring program designed to ensure that effluent limitations and water quality standards are being met by the POTWs, 2) a nonpoint source monitoring program to better identify agricultural and other nutrient sources and evaluate the effectiveness of best management practices in meeting water quality objectives, and 3) a watershed-scale monitoring to evaluate the effectiveness of the Implementation Plan in achieving water quality objectives for nutrient and nutrient effects to ensure compliance at key compliance points along Calleguas Creek and its tributaries.

4.3.1 Compliance Monitoring for POTWs

Effluent and receiving water monitoring requirements will be developed for the POTWs to ensure compliance with the limits for nitrogen species (including but not limited to ammonia, nitrate, nitrite, and nitrate plus nitrite). The frequency of sampling will be determined by the Regional Board to statistically demonstrate that the sampling frequency is sufficient to ensure that the effluent limits are met and that receiving water standards are not violated. Organic nitrogen will be included in the parameters to evaluate total nitrogen loadings to Calleguas Creek and its tributaries.

Receiving water monitoring requirements include, but are not limited to, water column measurements of temperature, pH and DO, ammonia, nitrate, nitrite, organic nitrogen and acute and chronic toxicity. The frequency of sampling will be determined by the Regional Board to statistically demonstrate that the sampling frequency is sufficient to ensure that the water quality standards are met. The monitoring program will also include sediment samples, if necessary, to ensure water quality standards for nutrients are attained. Observations for the presence of scum, odors, and the presence and extent of algal mats should be made at the same time the receiving waters are sampled.

Additional monitoring may be required to refine the point source loading estimates from minor sources. The Regional Board will re-estimate the magnitude of minor point source loading and determine if additional monitoring of these sources is required to refine the point source load estimates and allocate waste loads to the minor point sources.

4.3.2 Nonpoint Source Monitoring

The Calleguas Creek Watershed Planning Committee will be responsible for conducting the non-point source monitoring. This TMDL include monitoring to evaluate nutrient loadings associated with agricultural drainage and other nonpoint sources. The monitoring program will include both dry and wet weather discharges from agricultural, urban and open space sources. In addition, groundwater discharge to Calleguas Creek will also be analyzed for nutrients to determine the magnitude of these loading and the need for load allocations. A key objective of these studies will be to determine the effectiveness of agricultural BMPs in reducing nutrient loadings. Consequently, flow and analytical data for nutrients will be required to estimate loadings from non-point sources.

The Calleguas Creek Watershed Planning Committee will be responsible for submitting a Nonpoint Source Monitoring Workplan within for approval by the Executive Officer within one year of the effective date of the TMDL.

4.3.3 Watershed Monitoring

The Calleguas Creek Watershed Planning Committee will be responsible for conducting watershed monitoring. The TMDL includes watershed monitoring to establish compliance with water quality objectives for Calleguas Creek and its tributaries. In addition to the analytical parameters and flow data requirements, the watershed monitoring program will establish sampling locations from which representative samples can be obtained, including all listed tributaries. Monitoring results will be compared to the numeric instream targets identified in this TMDL to determine the effectiveness of the TMDL. Data on the extent and distribution of algal mats, scum and odors will be included in the watershed monitoring. The data will be used to provide further verification of the model and refine the TMDL to address nutrient effects as appropriate.

A focused watershed-wide study will also be conducted to assess extent and magnitude of algae impairment within the Calleguas Creek Watershed. Should it be confirmed that algae is a problem, this would trigger additional studies in Calleguas Creek in the next phase of permit renewal to 1) define the targets for algal abundance, scum and odors and 2) address factors controlling algal abundances and 3) develop an implementation process. Special assessment and monitoring of the unique physical and biochemical dynamics of Mugu Lagoon is included in the Watershed Monitoring Program.

The Calleguas Creek Watershed Planning Committee will be responsible for submitting a Watershed Management Monitoring Workplan within for approval by the Executive Officer within one year of the effective date of the TMDL.

4.3.4 Summary of Monitoring

The monitoring program is designed to provide information that will assure that water quality standards are being met throughout the watershed and to refine the source loading estimates. These efforts will provide information on the success of the TMDL to address the nitrogen related problems in the River and listed tributaries. Information generated by this program may be used to revise the

TMDL at the next NPDES permit cycle.

4.4 SPECIAL STUDIES

The Calleguas Creek Watershed Planning Committee is responsible for the TMDL special studies required by this TMDL and other TMDLs in the Calleguas Creek watershed. The Implementation Plan sets forth special studies to address issues associated with nutrient impairments of Calleguas Creek that currently require more data to resolve. These special studies include:

- Monitoring of minor point sources for nutrients to confirm assumptions that the loadings from these sources are minor;
- Monitoring of greenhouse discharges and runoff to assess loadings from these sources;
- Monitoring of groundwater extraction and discharges in the Arroyo Santa Rosa subwatershed and other areas that may add significant nutrient loadings to Calleguas Creek; and
- Additional studies of the type and extent of algae impairment in Calleguas Creek and Mugu Lagoon.

The Calleguas Creek Watershed Planning Committee will be responsible for submitting a Special Studies Workplan within for approval by the Executive Officer within one year of the effective date of the TMDL. The special studies will be completed within 3 years of the effective date of this TMDL by the Regional Board.

Table 23 summarizes the Implementation Plan Milestones.

4.5 COST ANALYSIS

This section summarizes the cost analysis associated with the Calleguas Creek Nutrient TMDL. The cost analysis includes a capital cost estimate for denitrification facilities and an estimate of the increase in user charges for implementation of denitrification. The cost analysis also includes an estimate of the costs for implementing agricultural BMPs.

Estimated costs were developed in the Technical Support Document based on literature values and costs incurred by the POTWs in the watershed that have installed nitrogen reduction treatment processes. The cost estimates were reviewed by Regional Board staff and found to be comparable to costs for similar facilities in the Los Angeles Region.

TABLE 23 IMPLEMENTATION PLAN MILESTONES

IMPLEMENTATION TASKS, MILESTONES AND PROVISIONS	COMPLETION DATE
WLA for ammonia apply to POTWs.	Effective Date of TMDL
Interim Limits for nitrate apply to POTWs.	Effective Date of TMDL
Formation of Nonpoint Source BMP Evaluation Committee.	Effective Date of TMDL
Submittal of Non Point Source Monitoring Workplan by Calleguas Creek Watershed Management Planning Committee.	1 year after Effective Date of TMDL
Submittal of Watershed Monitoring Workplan by Calleguas Creek Watershed Management Planning Committee.	1 year after Effective Date of TMDL
Submittal of Special Studies Workplan by Calleguas Creek Watershed Management Planning Committee	1 year after Effective Date of TMDL
Complete Special Studies for minor sources, greenhouses, and groundwater loadings.	3 years after Effective Date of TMDL
Completion of ammonia WER studies.	3 years after Effective Date of TMDL
Complete planning and preparation for construction of TMDL remedies to reduce non-point source nitrogen loads.	3 years after Effective Date of TMDL
Interim Limits for nitrate expire and nitrate WLAs apply to POTWs.	4 years after Effective Date of TMDL
Complete Special Studies for algae impairments of Calleguas Creek, its triubtaries and Mugu Lagoon.	5 years after Effective Date of TMDL
Regional Board consideration of revised water quality objectives for nitrogen compounds based on monitoring data, special studies, and ammonia WER, if appropriate.	6 years after Effective Date of TMDL
Final achievement of ammonia and oxidized nitrogen standards.	7 years after Effective Date of TMDL

The cost estimates address three different implementation measures: nitrification, denitrification, and agricultural BMPs. Facility costs for nitrogen removal are presented as capital, operation and maintenance, and present worth costs. These costs are then annualized based on a 7% annual interest rate and a 20-year period. The annualized costs are then compared to the State Water Resources Control Board Wastewater User Charge Survey Report, F.Y. 2000-01. Agricultural best management practice (BMP) costs were developed based on installation costs only, maintenance was not estimated.

4.5.1 Nitrification and Denitrification

Nitrification is required to remove ammonia from wastewater treatment plant effluent by converting it to other nitrogen forms, such as nitrite and nitrate. Denitrification converts these oxidized nitrogen forms into gaseous nitrogen which is released from the effluent. For most of the POTWs in the Calleguas Creek watershed, two different categories of nitrification and denitrification processes can be implemented. The first involves converting existing facilities to provide nitrification and denitrification. The second requires the construction of new facilities for nitrification and denitrification.

Conversion of existing facilities to provide nitrogen removal involves modifying existing activated sludge processes by adjusting the amount of aeration, the types of bacteria present in the sludge, and the solids residence time. Through these process adjustments, ammonia levels of less than 5 mg/L and nitrate plus nitrite concentrations of 9 mg/L-N on average can be achieved. The benefit of converting existing facilities relative to constructing new nitrogen removal facilities is that it is very cost effective, does not involve new construction, and does not significantly change existing operations and maintenance costs. However, nitrogen removal processes based on conversion of existing facilities are more difficult to control than new facilities specifically designed to remove nitrogen compounds. If a large amount of ammonia enters the treatment plant unexpectedly, it is possible that the ammonia will pass through the plant without being treated. As such, meeting instantaneous maximum effluent limits with this process could be difficult. Achieving consistent levels of nitrate and nitrite significantly below 9 mg/L-N is difficult in converted facilities. This process also adds some organic nitrogen loading to the effluent.

The costs for construction of new facilities for nitrification and denitrification are significantly greater than the conversion of existing facilities. However, the new facilities allow significantly more control over the nitrogen removal processes. Additionally, the new facilities can be designed to achieve greater nitrogen removal than the converted facilities.

Costs for nitrification and denitrification can vary significantly depending on the type of process used. For conversion of existing facilities, the costs are estimated in the range of $300,000 to $450,000 for each POTW in the watershed, depending on site and plant-specific conditions. This value is based on a three-time multiplier to the actual cost incurred by Hill Canyon to convert its existing facilities for pilot tests. The multiplier accounts for the differences in construction of a permanent facility from the costs for a pilot facility.

The estimated cost of the facilities being constructed for Moorpark is approximately $6,300,000 (KJC, 1995). This is the magnitude of costs that may be incurred if nitrification and denitrification facilities need to be built at any of the treatment plants. However, because Moorpark is a small treatment plant with percolation ponds and different processes from most of the other treatment plants in the watershed the cost estimates for other plants may not be specifically applicable.

The following tables summarize the costs of nitrification and denitrification for the POTWs. The estimated costs assume construction of new facilities that were based on literature values from a study by the EPA (EPA, 1977). Costs from this document were updated to March, 2000 costs using an ENR index of 6201 (vis-à-vis 2401 in 1976) in accordance with the Technical Support Document.

Table 24 summarizes nitrification costs and Table 25 summarizes denitrification costs for constructed facilities. Nitrification costs for Hill Canyon and Simi Valley are based on the costs for Moorpark reported in the Technical Support Document. Present worth costs are based on total estimated capital costs and an interest rate of 7% over 20 years for a separate stage nitrification and denitrification facility with a clarifier. If additional constructed facilities for the Camarillo and Simi Valley POTWs are not required and the plants can be modified to achieve the ammonia and oxidized nitrogen objectives, the estimated cost is approximately $600,000 ($300,000 each for Simi Valley and Camarillo).

TABLE 24 ESTIMATED NITRIFICATION COSTS FOR CONSTRUCTED FACILITIES

POTW	Present Worth Cost	Capital Cost	Annual O&M
Hill Canyon	$8,040,000	$6,000,000	$202,000
Simi Valley	$8,100,000	$6,000,000	$211,000
Camarillo	Completed	Completed	Completed
Camrosa	Completed	Completed	Completed
Moorpark	Completed	Completed	Completed

TABLE 25 ESTIMATED DENITRIFICATION COSTS FOR CONSTRUCTED FACILITIES

POTW	Present Worth Cost	Capital Cost	O&M
Hill Canyon	$14,020,000	$4,170,000	$930,000
Simi Valley	$14,700,000	$4,300,000	$980,000
Camarillo	$7,290,000	$3,180,000	$390,000
Camarillo	Completed	Completed	Completed
Camrosa	Completed	Completed	Completed
Moorpark	Completed	Completed	Completed

Nitrification costs are not attributable to this TMDL because these costs are necessary to comply with the ammonia objective previously required by the *Basin Plan*. However, additional control of the processes to meet requirements for algae/DO and potentially the oxidized nitrogen TMDL would require the construction of higher cost facilities and the addition of greater annual operations and maintenance costs.

4.5.2 Cost Analysis

In order to estimate the effect on costs to end users of this TMDL, the present worth costs for construction of denitrification facilities at the Simi Valley were annualized and compared to the current users charges.

The annualized costs for construction and operation and maintenance of a denitrication facility at Simi Valley ($14,700,000) are $1,387,582 or monthly costs of $115,631. Based on a population served of 102,000 and an average of 4.5 persons per household, it is assumed that the number of sewer connections is 22,667. Thus, the annualized costs on a monthly basis per household for denitrification facilities at Simi Valley is estimated to be $5.10. Based on the average users fee reported in the State Water Resources Control Board User Charge Survey Report, $16.10, the costs for implementing the TMDL represent as much as a 32% increase. It is noted, that the current user costs for Simi Valley are below the statewide and Ventura County averages of $19.82 and $23.15, respectively. Thus, the cost estimate for denitrification facilities will still remain below the Ventura County average and exceed the statewide average by 12%.

4.5.3 Agriculture Best Management Practices (BMPs)

Costs to implement agricultural BMPs are dependent on the extent to which BMPs have already been implemented in the watershed. Because this information is not readily available, several assumptions were made to estimate agricultural BMP costs. First, it is assumed that there is minimal implementation of agricultural BMPs. Although it is known that some farms likely employ some of these measures already, there is no way to estimate the number that do at this time. Secondly, each BMP listed was assumed to have been implemented separately from the other BMPs. In reality, some BMPs may be implemented together and therefore reduce the costs. Finally, implementation of the BMPs was assumed to occur concurrently and consistently across all of the agricultural acreage in the watershed.

Table 26 summarizes the estimated costs for each BMP. Using these costs and an estimated agricultural acreage of 57,500 acres in the Calleguas Creek watershed, estimated watershed costs were determined.

TABLE 26 ESTIMATED AGRICULTURAL BMP COSTS

Best Management Practice	Unit	Cost per unit [1]	Watershed Cost
Conservation Tillage (329)			
No Till	acre	($2.90)	($166,750)
Mulch Till	acre	$17.20	$989,000
Contour Farming (330)	acre	$61.90	$649,950
Contour Orchard and Other Fruit Area (331)	acre	$131.80	$1,383,900
Crop Residue Use (344)			
Chopping and Chopping Waste	acre	$48.75	$2,803,125
Mulching using min. Tillage	acre	$20.10	$1,155,750
Filter Strip (393)			
Filter Strip (10-20 ft wide)	acre	$7,377.75	$1,381,473
Filter Strip (20-40 ft wide)	acre	$7,377.75	$2,762,945
Filter Strip (40-60 ft wide)	acre	$7,377.75	$5,525,890
Buffer Strip (20-30 ft wide)	acre	$1,217.70	$456,025
Landscaping (20-30 ft wide)	acre	$2,263.45	$847,655
Grassed Waterway (412)	acre	$7,377.75	$6,907,363
Hillside Bench (192)	acre	$1,080.15	$11,341,575
Irrigation System: Sprinkler (442)	acre	$830.90	$47,776,750
Irrigation System: Trickle (441)			
Microspray System	acre	$2,320.80	$133,446,000
Drip Irrigation	acre	$3,123.00	$179,572,500
Irrigation System			
Tail water Recovery (447)	each	$16,904.40	unknown
Irrigation Water Management (449)	acre	$458.40	$26,358,000
Runoff Management system (570)			
Sediment Basin (350)	each	$573,430.70	unknown
Infiltration Trench	per foot	$51.60	unknown
Sediment Trap, Box Inlet	each	$593.10	unknown

1. Based on average costs presented in “Calleguas Creek Watershed Erosion and Sediment Control Plan for Mugu Lagoon”, National Resources Conservation Service, May 1995.

Watershed costs for each BMP were determined based on the acreage in the watershed to which the BMP could be applied. Tillage, crop residue, and irrigation systems were assumed to be implemented on all the agricultural acreage in the watershed. Contour farming, contour orchards, and hillside benches were estimated for agricultural acreage in hilly areas (estimated to be 10,500 acres). Filter strips were assumed to be installed along the main channel and tributaries in agricultural areas for a total of 157 miles in the watershed. For simplicity, grassed waterways were assumed to be applied to the same miles of the waterways as the filter strips. The number of sediment basins, infiltration trenches, and sediment traps depend greatly on the amount of space available to install these devices. This information was not readily available, so watershed costs were not estimated for these BMPs. Because the number of individual farms in the watershed was not known, it was not possible to estimate the watershed cost for tail water recovery systems.

As shown in Table 26, the BMP costs for agricultural on a watershed basis range from low to high cost, depending on the BMP. However, most of these BMPs would provide treatment benefits for constituents other than just nitrogen compounds. The overall costs will depend on the BMPs selected as well as extent of BMP implementation.

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